Journal of Natural Resources and Environmental Management
http://dx.doi.org/10.29244/jpsl.14.4.708

RESEARCH ARTICLE

Partial Least Square-Structural Equation Modeling as a Model of Community Participation in Macroplastic Waste Management in Cikapundung River (Case Study: Baleendah District) Bandung Regency

Farah Fahriyatun Mufidah[a,b], Nandi Kosmaryandi[c], Taryono[d], Sigid Hariyadi[d]

[a] Study Program of Natural Resources and Environmental Management, Graduate School of IPB University, IPB Baranangsiang Campus, Bogor, 16153, Indonesia

[b] Center for Environmental Research (PPLH) IPB University, IPB Darmaga Campus, Bogor, 16680, Indonesia

[c] Departement of Forest Resources Conservation and Ecotourism, Faculty of Forestry and Environment, IPB University, IPB Darmaga Campus, Bogor, 16680, Indonesia

[d] Departement of Aquatic Resources Management, Faculty of Fisheries and Marine Science, IPB University, IPB Darmaga Campus, Bogor, 16680, Indonesia

Article History
Received
14 September 2023
Revised 12 October 2023
Accepted 02 January 2024

Keywords
management, partial least square, plastic, structural equation modeling, waste

ABSTRACT

Waste is an environmental issue owing to its increasing amount. The type of waste that is currently an important problem is plastic waste, which can endanger living things and the environment. This study aimed to analyze the community participation factors that affect waste management. This study used interview methods and completed questionnaires from as many as 50 respondents in Baleendah District, West Java Province. The collected data were analyzed using the Partial Least Square-Structural Equation Modeling (PLS-SEM) method with the approach of several latent variables, each of which was equipped with indicators. The PLS-SEM model was evaluated using the Outer Model and Inner Models. The results showed that, in the measurement model, all indicators were valid and reliable for measuring the constructed construct. In the structural model of the results of hypothesis testing with the bootstrapping method, it can be concluded that the variables of External Factors and Waste Management significantly affect the variables of Waste Management; the variable of Waste Management significantly affects the variable Impact of Waste Management, while the variable of Waste Reduction insignificantly affects the variable of Waste Management. The results of this study can be used as recommendations for implementing strategies to increase community participation in plastic waste management.

Introduction

Daily human activity involves throwing away or producing waste. One of the largest sources of waste pollution in water is anthropogenic activities in humans [1–3]. The size comparison of macroplastic waste was > 2.5 cm, mesoplastic was 0.5 to 2.5 cm, and microplastic was < 5 mm [4]. Another opinion is that plastic waste with particles > 1 cm is called macroplastic waste, which can cause long-term health problems, environmental damage, and affect ecosystem function [5–8]. The amount of waste generated in Indonesia remains high every year. Based on data from the *Sistem Informasi Pengelolaan Sampah Nasional* (SIPSN) - Ministry of Environment and Forestry 2022, the total waste generation in Indonesia is still quite high at 29,637,898.45 tons year^{-1}. Efforts to reduce waste have been made by the government and the community to achieve a waste reduction rate of 14.80% (4,384,957.90 tons year^{-1}). The waste generated was still not managed properly at 36.41% (10,790,283.58 tons ha^{-1}). These data are the results of the input carried out by 274 districts/cities throughout Indonesia in 2022.

Corresponding Author: Farah Fahriyatun Mufidah fm.farah97@gmail.com Study Program of Natural Resources and Environmental Management, Graduate School of IPB University, IPB Baranangsiang Campus, Bogor, Indonesia.

© 2024 Mufidah et al. This is an open-access article distributed under the terms of the Creative Commons Attribution (CC BY) license, allowing unrestricted use, distribution, and reproduction in any medium, provided proper credit is given to the original authors.
Think twice before printing this journal paper. Save paper, trees, and Earth!

The types of waste that dominated waste generation were food waste (40.1%), plastic (18.5%), and broken wood/branches/leaves (13.2%). Food scraps and broken wood/branches/leaves fall into the easily biodegradable organic waste category, whereas plastic waste falls into the difficult-to-decompose inorganic waste category. This type of plastic waste is difficult to decompose or degrade. The decomposition process requires tens to thousands of years. Many household appliances that are used daily are made of plastic, ranging from cutlery to cookware and toiletries; therefore, the demand for plastic-based products is still high. The nature of plastic, which is light and convenient for people's daily lives, has encouraged the industrial sector to produce more products made from plastic [9].

One of the rivers that is the source of pollution is the Cikapundung River, which flows through three administrative areas: Bandung Regency, West Bandung Regency, and Bandung City. The Cikapundung River is part of the Citarum Watershed. Based on data from Citarum Harum, West Java Province, the amount of waste generated in the Citarum Watershed Area is 15,838 tons per day, with the largest types of waste being organic waste (55%) and plastic waste (15.35%). Plastic waste pollutes the environment through waste disposal, careless waste disposal, natural disasters, and densely populated residential environments [10,11]. In an effort to manage the Citarum Watershed, the government has undertaken a number of initiatives, including the Citarum Harum program under Government Regulation [12], to deal with waste problems in the Citarum Watershed.

As the primary drainage channel for the city center in West Java, the Cikapundung River is one of the strategically important rivers whose conditions must be carefully monitored. The utilization of water for various purposes must be done wisely while still paying attention to water availability for current and future generations because water has great potential and benefits to the environment [13,14]. However, the condition of the river is worsening because of the disruption to the function of the riverbank as a water catchment area. Environmental disturbances that affect river function include: (1) The more densely populated an area is, the more impact it will have on the quality of the environment. In a study by Noeraga et al. [15], population growth has an impact on meeting the increasing need for clean water, and (2) Poor management of river ecosystems will affects water catchment areas when it rains [16,17].

Water catchment areas are less functional; therefore, they cannot hold water, causing flooding due to rainwater runoff. Often, the water that rises to the surface of residential areas is accompanied by rubbish carried by the current, thereby reducing water quality; (3) The reason people throw garbage into open spaces is the ease and habit of throwing garbage into open spaces and the lack of facilities and infrastructure for trash bins [18]. The community is the key to management. Community involvement can range from the strategy creation process to strategy implementation [19,20]. The community can participate in small things such as sorting waste to process waste into crafts or items that can be reused; things like this can have a very significant effect on environmental cleanliness [21]. Therefore, it is important to conduct this research to determine the influence of community participation on waste management in the Cikapundung River.

Material and Methods

Study Area

The research was conducted in the Cikapundung River Basin because it represents a residential area and the center of community activity (Figure 1). Sampling of location points is based on locations that are centers of community activities that have the potential to pollute environmental conditions and community residential areas that have the potential to experience flooding. This research was conducted from June 2022 to March 2023.

Research Method

The data collection method was carried out by directly observing the conditions of the research location, studying literature, interviewing, and filling out questionnaires for the community. Retrieval of data by the interview method using 50 respondents. The people who were used as respondents were selected using a purposive sampling technique based on predetermined criteria. The criteria were set as follows: (1) respondents are residents of Baleendah District who have lived on the banks of the Cikapundung River for at least the last 12 months, and (2) respondents were at least 17 years old.

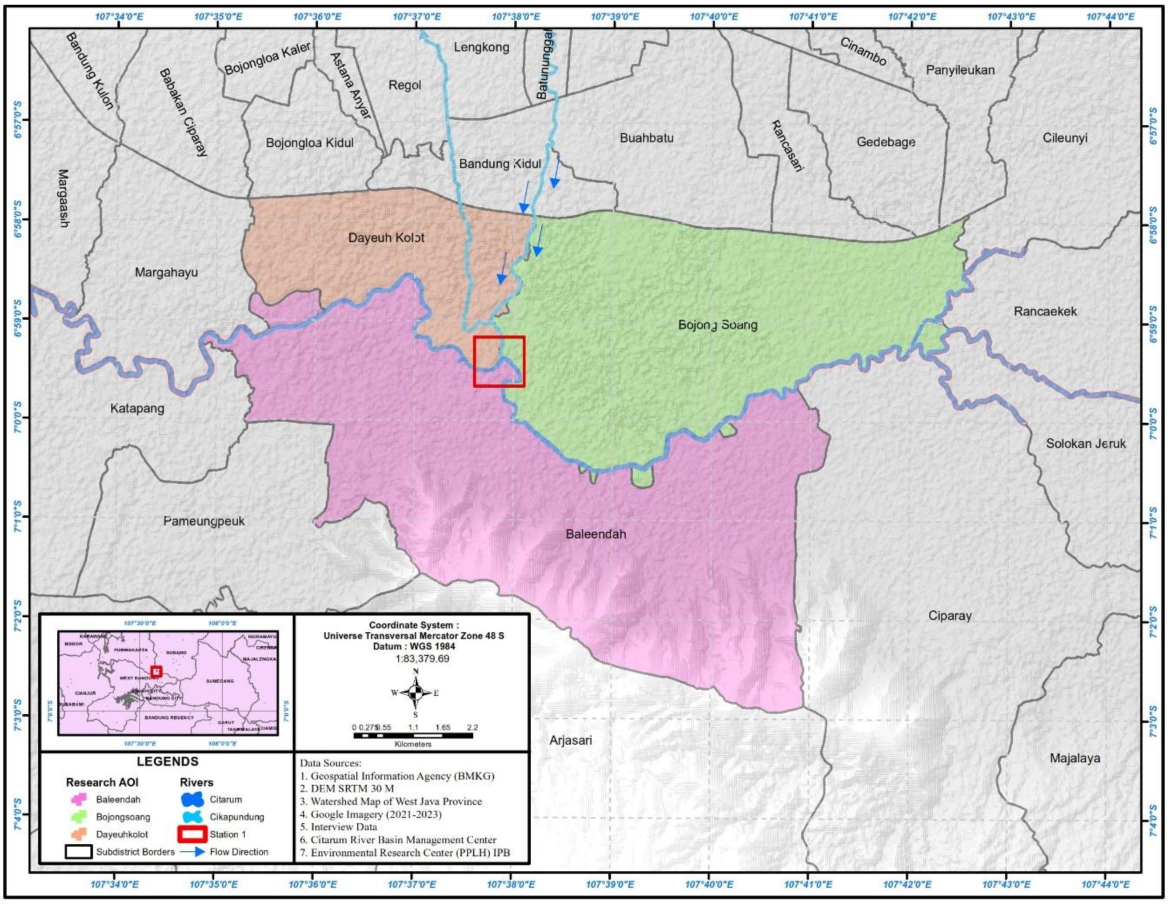

Figure 1. River flow map of Cikapundunng River.

Analysis Method

The Partial Least Square-Structural Equation Modeling (PLS-SEM) method is a modeling strategy that analyzes latent variables, formative and reflective measurement models, and one indicator without creating identification issues [22]. Partial Least Square can be used to confirm theories and build relationships where there is no theoretical basis [23]. Structural Equation Modeling-Partial Least Square is interpreted through diagram images in the form of illustrations of hypotheses and the variables to be tested. The model in this research is composed of Exogenous Variables (X1, X2, and X3) and Endogenous Variables (Y1, Y2), which are indicators for each constructed variable. These indicators form the basis for compiling a questionnaire, which is a method for collecting research data. The research data were input and processed using the Smart PLS application to produce a path model that describes the relationship between latent variables or constructs based on logical reasoning and theory. The path model consists of a measurement model and a structural model. Table 1 presents the variables and indicators used in this study.

Table 1. PLS-SEM variables and indicators.

Variable	Code	Indicator
Exogenous Variable		
Waste Reduction (WR): X1	B1	Community participation in reducing the intensity of waste generation
	B2	Bring your own shopping bag
	B3	Bring your own cutlery
	B4	Bring your own drinking bottle
	B5	Purchasing products by paying attention to environmentally friendly packaging (green label)
	B6	Using recycled products
	B7	Giving usable items to those in need

Variable	Code	Indicator
	B8	Reducing the use of plastic and replacing it with products that can be recycled, such as cardboard, newspapers, and used paper
Waste Handling (WH): X2	C1	Community participation in handling waste before it is disposed of at the Temporary Storage Site, Integrated Waste Treatment Site, or Waste Bank
	C2	Sort waste according to its type (organic, inorganic, recyclable, hazardous materials) before disposal
	C3	Throw garbage into the nearest trash can or Temporary Storage Site
	C4	Transport waste from Temporary Storage Site and/or Reduce, Reuse, Recycle (3R) Temporary Storage Site to Final Processing Sites/ Integrated Waste Treatment Site
	C5	Distributing waste to the Garbage Bank
	C6	Recycle waste into valuable items that can be reused
	C7	Making or turning waste into compost
	C8	Collecting waste and then selling it to collectors
	C9	Repairing goods that can still be used so as to reduce consumptive behaviour
External Factors (EF): X3	D1	The role of external factors in waste management
	D2	Providing assistance in the form of personnel to assist the waste management program
	D3	Providing assistance in the form of funds to help waste management programs
	D4	Providing technical assistance in the form of waste management programs
	D5	Supervision is carried out by routine patrol officers in the river area
	D6	Provides easy access to waste disposal
	D7	Conduct outreach to the public regarding proper waste handling and its impact on society and the environment
	D8	Hold meetings with the community to discuss waste management
	D9	Give appreciation to the people who have taken care of the environment
	D10	Provide sanctions for people who have violated environmental cleanliness
	D11	Conduct monitoring and evaluation of the environment in the river area
	D12	Providing facilities for the community to sell businesses from recycled waste
	D13	Providing facilities and infrastructure for landfills and waste banks
Endogenous Variable		
Waste Management (WM): Y4	E1	The role of the community in assisting waste management
	E2	Do social service work
	E3	Participate in counselling on proper waste handling and its impact on society and the environment
	E4	Assist in formulating waste management policies
	E5	Provide suggestions, considerations, and suggestions in the framework of waste management
	E6	Creating new businesses at the community level from the results of waste management
	E7	Make a garbage disposal in each house
	E8	Maintain facilities and infrastructure for waste management
	E9	Help manage Temporary Storage Site and/or Waste Bank
	E10	Pay garbage fees for waste management costs
Impact of Waste Management (IWM): Y5	F1	The benefits of waste management
	F2	Improving environmental cleanliness in community settlements and areas around rivers
	F3	Forming a healthy environment for society and the environment
	F4	Creating a neat and comfortable environment to live in
	F5	Creating a safe environment from flood disasters
	F6	Maintain harmony between communities
	F7	Building cooperation between the community and internal parties
	F8	Reducing consumptive behavior
	F9	Helping to increase the economy from the results of waste management efforts
	F10	Creating new jobs from the results of waste management

Outer Model

In the PLS-SEM model using a convergent validity test approach, a loading factor value of < 0.70 is stated as a valid measure for an indicator measuring constructs and shows that the indicator can be explained by the construct being measured. A loading factor value < 0.70 indicates that the test is valid because the latent variables can reflect more than 70% of each indicator. The latent variables formulated in the research model included five variables with 50 indicators. The next testing approach was the Average Variance Extracted (AVE) to determine the average loading squared from the construct indicators. A construct typically explains more than half of the variation in its indicators if the AVE value is 0.50 or above [24].

The PLS-SEM model was tested using the discriminant validity approach by comparing the values in the cross-loading table. The discriminant validity of a latent variable demonstrates how distinct it is from the other concepts. Validity was tested by assessing discriminant validity through the cross-loading approach, which was assessed based on: (1) the square root of AVE is greater than the correlation between constructs, (2) the loading of indicators to the construct measured is greater than the loading to other constructs. If the measured loading value is greater than the loading value for other constructs (cross-loading), it is declared valid. The significance of loading in comprehending a factor matrix increases with the loading factor value.

The validity and reliability of the measurement model were examined in the final step using Cronbach's alpha. A reliability test was performed to show the precision, consistency, and correctness of the variables and the indicators that comprise those variables in assessing the model construct. The reliability test can be said to be reliable if it correlates more than 0.70 with the construct you want to measure. This shows that the indicators are consistent when measuring the latent variables. The next stage in the reliability test was to approach the composite reliability method to consider the different loadings of the indicators. The interpretation of composite reliability and Cronbach's alpha in exploratory research, which is still acceptable is 0.60 to 0.70. A validity test was then conducted to evaluate the first convergent validity through the factor-loading approach of each indicator. A brief guide regarding the evaluation of measurement models is provided in Table 2.

Table 2. Measurement model evaluation guide.

Validity and reliability test	Test type	Rule of thumb
Internal consistency reliability	Cronbach's alpha	> 0.70 declared reliable. > 0.60 is still acceptable for exploratory research
	Composite reliability	0.60 to 0.70 is still acceptable for exploratory research
Convergent validity	Loading factor	> 0.70 declared reliable
	Average Variance Extracted (AVE)	> 0.50 declared reliable
Discriminant validity	Cross-loading	Loading indicator > loading into another construct
	The square root of AVE and correlation between constructs	The square root of AVE > correlation between constructs

Source: Sholihin and Ratmono [22].

Inner Model

Testing is performed in the structural model (inner model) to ascertain the cause-and-effect connections between the latent variables. Tests were carried out using bootstrapping analysis with 36 samples for resampling and 5,000 repetitions of the sample on the path coefficients, which produced empirical t- and p-values for all the path coefficients. In the next stage, the structural test was measured by examining the R-squared value of the model. The coefficient of determination (R^2) describes the extent to which exogenous variables can explain endogenous variables. Structural model evaluation was carried out by calculating the R^2 value, which ranged from 0 to 1, with a greater value (closer to 1) indicating a higher level of accuracy for predicting a model. In each path association, the findings are deemed significant if the t-statistic value is higher than 1.96 (significance level 5%) or more than 1.65 (significance level 10%).

Result and Discussion

Respondent's Characteristics

The respondents included 26 women (52%) and 24 men (48%). The age level of the respondents were divided into several age groups based on data from the Republic of Indonesia's Ministry of Health [25]. In this study, most patients were aged between 26 and 35 years old. The majority of respondents in the study worked as private employees, 16 people (32%), and freelance 12 people (24%) had the most dominant level of education, namely senior high school (22 people, 44%). Respondents' characteristics are shown in Figure 2.

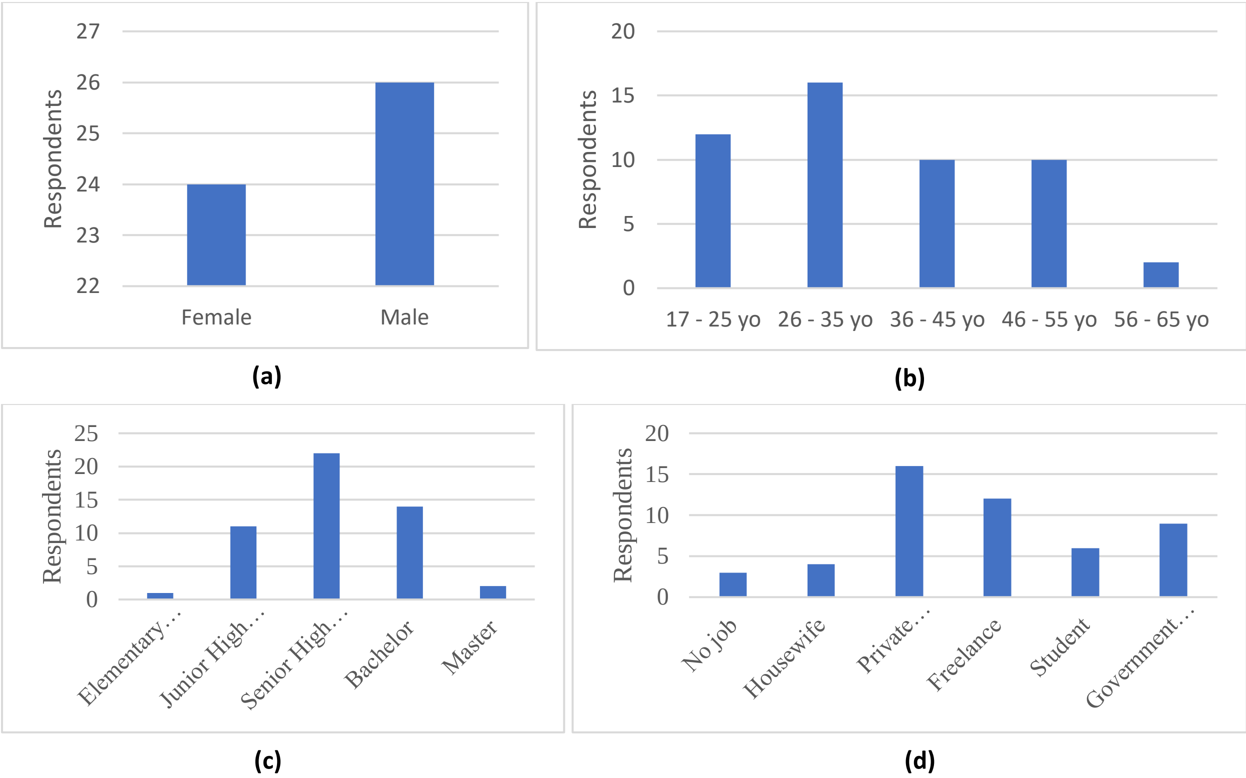

Figure 2. Characteristics of the respondents; (a) Gender, (b) Age, (c) Educational background, (d) Profession.

Outer Model

Convergent Validity

Based on the results of the evaluation of the measurement model in the convergent validity test, it was shown that as many as 14 indicators were invalid because the loading factor value was < 0.70. All indicators met the requirements of convergent validity testing, and invalid indicators were eliminated from the measurement model to maintain the model fit. The largest loading factor value in the model path diagram is found in the Waste Management Impact variable indicator F4, which creates a neat and comfortable environment, with a value of 0.989. The largest loading factor value in the Waste Reduction variable indicator B8 was reducing the use of plastic and replacing it with products that can be recycled, such as cardboard, newspapers, and used paper, with a value of 0.874. According to research conducted by Yusvita et al. [26], using tote bags instead of plastic bags can reduce plastic waste.

The government also plays an active role in implementing plastic waste reduction programs by regulating plastic waste reduction. The largest loading factor value in the Waste Handling variable indicator C6 is recycling waste into valuable goods, so that it can be reused with a value of 0.854. According to research conducted by Siahaan et al. [27], handling waste by utilizing and recycling waste through the production of organic compost fertilizer can reduce the volume of waste to create a quality environment. The largest loading factor value in the external factor indicator variable D11 is 0.932, which is obtained by conducting monitoring and evaluation of the environment in the river area. The largest loading factor value is in the E3 indicator Waste Management variable, namely participating in counselling about proper waste handling and its impact on society and the environment (0.941). The final results of the path diagram are shown in Figure 3.

A high convergent validity value indicates a better correlation value between the indicators that constitute a construct [28]. The AVE value criterion is > 0.5 (square of 0.708), indicating that a construct can, on average, account for more than half of the variance in its indicators. In the results of research by Umroh [29], the AVE value obtained was above the threshold of > 0.5, with the highest value being environmental awareness of 0.850. Based on the results of the measurement model test, the AVE values for the IWM, WM, WR, WH, and EF variables had an AVE value > 0.5, which met the validity test criteria. Comparing the results of several variables, the Waste Handling variable's AVE value is the one with the lowest results, but this value is still within the threshold of > 0.5, so it is valid. The Waste Handling variable explained 59.4% of the variance in the seven constituent indicators. Based on the AVE values of the five variables, it can be said that the measuring model created is reliable and capable of producing accurate measurements. The AVE values are presented in Table 3.

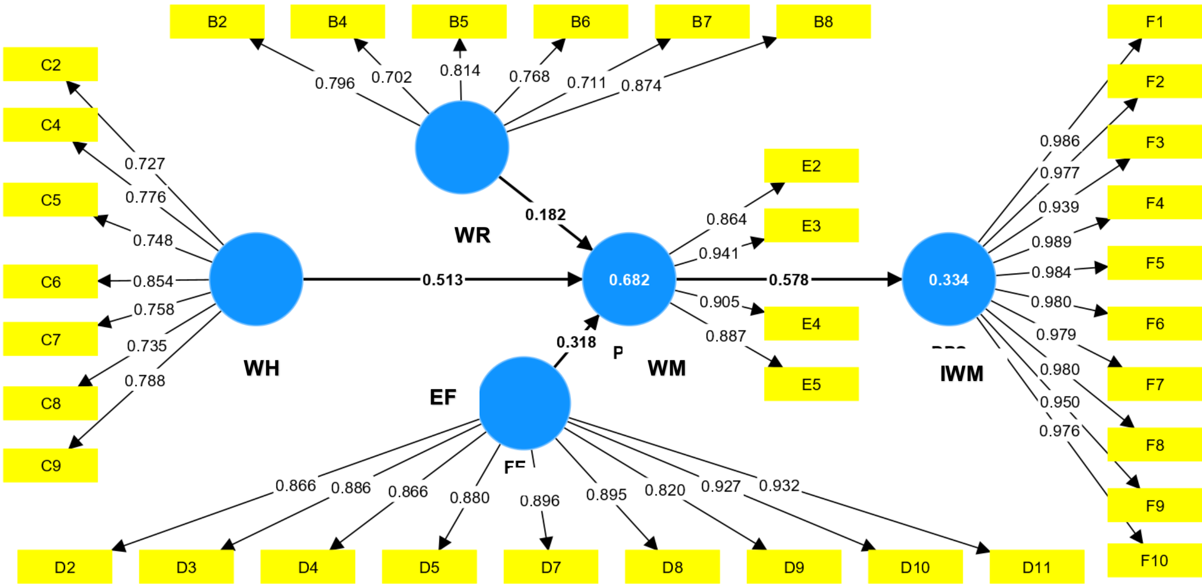

Figure 3. Characteristics of the respondents.

Table 3. AVE value in Baleendah District.

Variable	AVE
Impact of Waste Management (IWM)	0.949
Waste Management (WM)	0.809
Waste Reduction (WR)	0.608
Waste Handling (WH)	0.594
External Factors (EF)	0.785

Discriminant Validity

Based on the data in Table 4, the loading factor values obtained for the five latent variables for each indicator were greater than the measured loading factor values. For example, the B2 indicator that measures WR is 0.796 and has a higher loading value than the IWM, EF, WH, and WM of 0.548, 0.253, 0.642, and 0.586, respectively. This shows that discriminant validity was fulfilled. The values of the cross-loading analysis are listed in Table 4.

Table 4. Analysis of cross-loading in Baleendah District.

Variable	IWM	EF	WH	WM	WR
B2	0.548	0.253	0.642	0.586	**0.796**
B4	0.583	0.023	0.360	0.253	**0.702**
B5	0.382	0.220	0.617	0.489	**0.814**
B6	0.417	0.358	0.444	0.535	**0.768**
B7	0.557	-0.122	0.330	0.239	**0.711**
B8	0.453	0.322	0.479	0.501	**0.874**
C2	0.552	0.397	**0.727**	0.539	0.613
C4	0.212	0.284	**0.776**	0.588	0.402
C5	0.264	0.216	**0.748**	0.487	0.381
C6	0.368	0.348	**0.854**	0.683	0.504
C7	0.338	0.238	**0.758**	0.602	0.612

Variable	IWM	EF	WH	WM	WR
C8	0.050	0.436	**0.735**	0.534	0.329
C9	0.620	0.256	**0.788**	0.623	0.603
D2	0.218	**0.866**	0.302	0.425	0.225
D3	0.078	**0.886**	0.350	0.467	0.164
D4	0.139	**0.866**	0.335	0.446	0.211
D5	0.035	**0.880**	0.377	0.410	0.209
D7	0.232	**0.896**	0.319	0.514	0.282
D8	0.289	**0.895**	0.342	0.499	0.346
D9	0.181	**0.820**	0.414	0.568	0.218
D10	0.199	**0.927**	0.367	0.599	0.252
D11	0.296	**0.932**	0.381	0.590	0.330
E2	0.699	0.512	0.689	**0.864**	0.602
E3	0.549	0.611	0.715	**0.941**	0.607
E4	0.382	0.484	0.712	**0.905**	0.449
E5	0.387	0.441	0.595	**0.887**	0.473
F1	**0.986**	0.229	0.475	0.586	0.601
F2	**0.977**	0.255	0.442	0.565	0.592
F3	**0.939**	0.202	0.443	0.547	0.528
F4	**0.989**	0.217	0.432	0.562	0.583
F5	**0.984**	0.212	0.404	0.556	0.570
F6	**0.980**	0.193	0.418	0.552	0.584
F7	**0.979**	0.204	0.470	0.574	0.585
F8	**0.980**	0.205	0.466	0.579	0.608
F9	**0.950**	0.189	0.369	0.510	0.573
F10	**0.976**	0.196	0.475	0.591	0.625

Validity and Reliability

Based on the Cronbach's alpha value in Table 5, it can be seen that the five variables have a Cronbach's alpha value above the minimum criterion, which is greater than 0.6, so these variables are declared valid in measuring the intended latent variable. The largest Cronbach's alpha value was for the External Factor variable, which reached a value of 0.966. Cronbach's alpha must still be refined using a composite reliability approach. Based on the results in Table 5, the five variables have a composite reliability value above 0.70, which means that the evaluation of the measurement model built into this study is valid and reliable. The highest composite reliability value was for the External Factor variable, which reached a value of 0.970.

Table 5. Cronbach’s alpha and composite reliability value in Baleendah District.

Variable	Cronbach’s alpha	Composite reliability
Impact of Waste Management (IWM)	0.994	0.995
Waste Management (WM)	0.922	0.944
Waste Reduction (WR)	0.875	0.902
Waste Handling (WH)	0.886	0.911
External Factors (EF)	0.966	0.970

Inner Model

Coefficient of Determination

Based on the data presented in Table 6, the endogenous variable, namely the Impact of Waste Management, can be explained by 33.40% of the exogenous variable of Waste Management, whereas the remaining 66.60% is explained by other variables that are not present in the research model. The second endogenous variable, namely, the Waste Management variable, can be explained by 66.80% of the exogenous variables of Waste Reduction, Waste Management, and External Factors, while the remaining 33.20% is explained by other variables that are not present in the research model. As in the research by Zakia et al. [30], the waste management model in the Citarum watershed should involve external factors such as stakeholders and the socio-culture of the local community and pay attention to the characteristics of the waste to increase the waste reduction rate. The coefficient of determination R^2 has limitations in the form of increasing bias if there are more exogenous variables in the study. This bias can be minimized using the adjusted R^2 when comparing models with different numbers of exogenous variables [24]. Table 6 presents the R-squared values of the structural model.

Table 6. Coefficient of determination.

	R-square	R-square adjusted
Impact of Waste Management (IWM)	0.334	0.320
Waste Management (WM)	0.682	0.661

Hypothesis Testing

The original sample value was used as a benchmark to determine the positive or negative relationship between each variable. A t-statistic value > 1.96 or p-values < 0.05 indicates a significant result so that the hypothesis can be accepted, while a t-statistic value < 1.96 indicates an insignificant result, so the hypothesis is rejected. Based on the data presented in Table 7, it can be concluded that (1) there is a positive relationship between the external factor variable and the Waste Management variable (0.318). External Factor Variables significantly affected Waste Management variables. This is evidenced by the t-statistics measurement results of 2.775 or a p-value of 0.006; because the t-statistics results are > 1.96 or p-values < 0.05, Hypothesis 1 can be accepted. Hypothesis 1 is supported by the research of Karnowati et al. [31], which shows the results of a p-value for external factors of 0.001, proving that external factors have a significant positive influence on community participation in waste management; (2) There is a positive relationship between the Waste Handling variable and the Waste Management variable of 0.513.

The Waste Handling variable significantly influenced the Waste Management variable. This is evidenced by the results of the t-statistics measurement of 4.061 or a p-value of 0.000; because the results of the t-statistics are > 1.96 or p-values < 0.05, Hypothesis 2 can be accepted; (3) There is a positive relationship between the waste management variable and the waste management impact variable of 0.578. The Waste Management variable significantly influences the Waste Management Impact variable. This is evidenced by the results of the t-statistics measurement of 6.393 or a p-value of 0.000; because the results of the t-statistics are > 1.96 or p-values < 0.05, Hypothesis 3 can be accepted; (4) There is a positive relationship between the waste reduction variable and the waste management variable of 0.182. The Waste Reduction variable has no significant effect on the Waste Management variable but still has a positive value. This is evidenced by the results of the t-statistics measurement of 1.885 or a p-value of 0.059; because the results of the t-statistics <1.96 or p-values < 0.05, Hypothesis 4 is rejected.

Table 7. Path coefficients value.

Variable	Original sample (O)	P-Values	t-statistics (|O/STDEV|)	Hypothesis decision
External Factors → Waste Management	0.318	0.006*	2.775	Accepted
Waste Handling → Waste Management	0.513	0.000*	4.061	Accepted
Waste Management → Impact of Waste Management	0.578	0.000*	6.393	Accepted
Waste Reduce → Waste Management	0.182	0.059*	1.885	Rejected

* Significant with a significance level of 5%.

Conclusion

Based on the results of the research model analysis, the External Factors and Waste Handling variables influenced the Waste Management variables. Waste management carried out well and correctly will have a significant influence on the impact felt by the community. In this study, the factors that influenced waste management were external factors and waste handling. Almost all indicators show that participation in External Factors and Waste Management plays an important role in Waste Management. The dominant external factor indicator is the provision of monitoring and evaluation of the environment in a river area that involves the community. Monitoring and evaluation activities can be a forum for external factors and the community to support each other in the success of waste management. In the Waste Management indicator, the dominant influence of community participation is the recycling of waste into valuable items that can be reused. The Waste Reduction variable does not significantly influence the Waste Management variable. This means that the waste reduction activities carried out did not been able to improve the waste management. Activities that can be carried out to increase community participation in waste management include holding outreach about environmentally friendly products (plastic substitutes) that can be used repeatedly and the impact of plastic waste in the long term so that people are more aware of the dangers posed by plastic waste.

Acknowledgement

The author would like to thank NIVA (Norwegian Institute for Water Research) for funding the research activities. The author would also like to thank the ASEANO Project for funding and facilitating my research so that it could be completed. Thanks also to the Citarum River macroplastic research team.

References

1. Wei, C.L.; Rowe, G.T.; Nunnally, C.C.; Wicksten, M.K. Anthropogenic "Litter" and macrophyte detritus in the deep Northern Gulf of Mexico. *Mar. Pollut. Bull.* **2012**, *64*, 966–973, doi:10.1016/j.marpolbul.2012.02.015.
2. Wulandari, W.; Rafii, A.; Ghitarina, G. Kelimpahan Makroplastik di Wilayah Perairan Muara Sembilang Samboja Kabupaten Kutai Kartanegara. *Trop Aquat Sci.* **2023**, *1*, 54–61, doi:10.30872/tas.v1i1.473.
3. Taryono; Pe, E.O.L.; Wardiatno, Y.; Mashar, A. Macroplastic distribution, abundance, and composition which flows to Cimandiri estuary, West Java. *IOP Conf Ser Earth Environ Sci.* **2020**, *420*, 012031, doi:10.1088/1755-1315/420/1/012031.
4. Lippiatt, S.; Opfer, S.; Arthur, C. *Marine Debris Monitoring and Assessment: Recommendations for Monitoring Debris Trends in The Marine Environment*; National Oceanic and Atmosphereic Administration: Washington DC, USA, 2013;
5. Hartmann, N.B.; Hüffer, T.; Thompson, R.C.; Hassellöv, M.; Verschoor, A.; Daugaard, A.E.; Rist, S.; Karlsson, T.; Brennholt, N.; Cole, M.; et al. Are We Speaking the Same Language? Recommendations for a Definition and Categorization Framework for Plastic Debris. *Environ Sci Technol.* **2019**, *53*, 1039–1047, doi:10.1021/acs.est.8b05297.
6. Cunha, M.C.; Tsiaras, K.; Marques, J.R.; Hatzonikolakis, Y.; Dias, L.C.; Triantaphyllidis, G. A multi-criteria assessment of the implementation of innovative technologies to achieve different levels of microplastics and macroplastics reduction. *Mar Pollut Bull.* **2023**, *191*, 1–12, doi:10.1016/j.marpolbul.2023.114906.
7. Jia, T.; Kapelan, Z.; de Vries, R.; Vriend, P.; Peereboom, E.C.; Okkerman, I.; Taormina, R. Deep learning for detecting macroplastic litter in water bodies: A review. *Water Res.* **2023**, *231*, 119632, doi:10.1016/j.watres.2023.119632.
8. Liro, M.; van Emmerik, T.H.M.; Zielonka, A.; Gallitelli, L.; Mihai, F.C. The unknown fate of macroplastic in mountain rivers. *Sci Total Environ.* **2023**, *865,* 161224, doi:10.1016/j.scitotenv.2022.161224.
9. Priliantini, A.; Krisyanti, K.; Situmeang, I.V. Pengaruh Kampanye #PantangPlastik terhadap Sikap Ramah Lingkungan (Survei pada Pengikut Instagram @GreenpeaceID). *J Komunikasi, Media dan Inform.* **2020**, *9*, 40–51, doi:10.31504/komunika.v9i1.2387.
10. Sekharan, S.; Samal, D.R.; Phuleria, H.C.; Chandel, M.K.; Gedam, S.; Kumar, R.; Sethi, V.; Supate, A.R.; Karmakar, S. River pollution monitoring over an industrial catchment in urban ecosystem: Challenges and proposed geospatial framework. *Environ Challenges.* **2022**, *7*, 100496, doi:10.1016/j.envc.2022.100496
11. Vriend, P.; Schoor, M.; Rus, M.; Oswald, S.B.; Collas, F.P.L. Macroplastic concentrations in the water column of the river Rhine increase with higher discharge. *Sci Total Environ.* **2023**, *900*, 165716, doi:10.1016/j.scitotenv.2023.165716.
12. Government Regulation. 2018. Presidential Regulation No. 15 of 2018 on The Acceleration of Control of Citarum Watershed Pollution Damage; State Secretariat of the Republic of Indonesia: Jakarta, ID, 2018;
13. Guo, H.; Goulden, M.; Chung, M.G.; Nyelele, C.; Egoh, B.; Keske, C.; Conklin, M.; Bales, R. Valuing the benefits of forest restoration on enhancing hydropower and water supply in California's Sierra Nevada. *Sci Total Environ.* **2023**, *876*, 162836, doi:10.1016/j.scitotenv.2023.162836.
14. Kukkola, A.; Runkel, R.L.; Schneidewind, U.; Murphy, S.F.; Kelleher, L.; Smith, S.; Nel, H.A.; Lynch, I.; Krause, S. Prevailing impacts of river management on microplastic transport in contrasting US streams: Rethinking global microplastic flux estimations. *Water Res.* **2023**, *240*, *120112*, doi:10.1016/j.watres.2023.120112.
15. Noeraga, M.A.A.; Yudana, G.; Rahayu, P. Pengaruh Pertumbuhan Penduduk dan Penggunaan Lahan Terhadap Kualitas Air Bersih. *J Universitas Sebelas Maret.* **2020**, *2*, 70–85, doi:17058-99984-1-Pb.

16. Patil, R.; Wei, Y.; Shulmeister, J. Change in centre of timing of streamflow and its implications for environmental water allocation and river ecosystem management. *Ecol Indic.* **2023**, *153*, 110444, doi:10.1016/j.ecolind.2023.110444.
17. Wijaya, K.; Permana, A.Y.; Swanto, N. Kawasan Bantaran Sungai Cikapundung Sebagai Permukiman Masyarakat Berpenghasilan Rendah (Mbr) Di Kota Bandung. *J Arsit ARCADE.* **2017**, *1*, 211–216, doi:10.31848/arcade.v1i2.7.
18. Asmal, I.; Walenna, M.A.; Nas, W.; Ridwan. Application of local wisdom in handling waste in coastal settlements as an effort to minimize waste production. *Environ Sustain Indic.* **2023**, *19*, 100283, doi:10.1016/j.indic.2023.100283.
19. Atanga, R.A. The role of local community leaders in flood disaster risk management strategy making in Accra. *Int J Disaster Risk Reduct.* **2020**, *43*, 101358, doi:10.1016/j.ijdrr.2019.101358.
20. Sattayapanich, T.; Janmaimool, P.; Chontanawat, J. Factors Affecting Community Participation in Environmental Corporate Social Responsibility Projects: Evidence from Mangrove Forest Management Project. *J Open Innov Technol Mark Complex.* **2022**, *8*, 1–28, doi:10.3390/joitmc8040209.
21. Iyabu, N.; Duludu, U.A.T.; Zubaidi, M. Peran Masyarakat Dalam Pengolahan Sampah Di Kelurahan Pentadu. *Jambura J Community Empower.* **2021**, *2*, 13–22, doi:10.37411/jjce.v2i1.691.
22. Sholihin, M.; Ratmono, D. *Analisis SEM-PLS dengan WARPLS 7.0 untuk Hubungan Nonlinier dalam Penelitian Sosial dan Bisnis*; Penerbit Andi: Yogyakarta, ID, 2013;
23. Jonathan, G.; Anondho, B. Perbandingan Antara Pls Sem Dan Analisis Faktor Untuk Identifikasi Faktor Pengaruh Eksternal Proyek. *JMTS J Mitra Tek Sipil.* **2018**, *1*, 123–132, doi:10.24912/jmts.v1i2.2668.
24. Hair, J.; Hollingsworth, C.L.; Randolph, A.B.; Chong, A.Y.L. An updated and expanded assessment of PLS-SEM in information systems research. *Ind Manag Data Syst.* **2017**, *117*, 442–458, doi:10.1108/IMDS-04-2016-0130.
25. Republic of Indonesia's Ministry of Health. *Profil Kesehatan Indonesia 2009*; Republic of Indonesia's Ministry of Health: Jakarta, ID, 2010; ISBN 978-602-8937-18-4.
26. Yusvita, G.; Rinjani, I.; Suminar, L.A.; Andira, E.R.; Wahyudin, W.; Sari, R.P. Analisis Usaha Tote Bag Ramah Lingkungan sebagai Solusi Guna Mengurangi Sampah Plastik. *Go-Integratif J Tek Sist dan Ind.* **2021**, *2*, 12–23, doi:10.35261/gijtsi.v2i01.5254.
27. Siahaan, U.; Eni, S.P.; Ulinata. Pengurangan Volume Sampah Dengan Memanfaatkan Dan Mendaur Ulang Sampah Melalui Kegiatan Pembuatan Pupuk Organik-Kompos. *J Comunita Servizio*. **2019**, *1*, 1–10, doi:10.33541/cs.v1i1.948.
28. Sholiha, E.U.N.; Salamah, M. Structural Equation Modeling-Partial Least Square for Modeling District/City Health Degrees in East Java. *J Sains Dan Seni Its.* **2015**, *4*, 169–174.
29. Umroh, J.S. The Influence of Attitude, Subjective Norm, and Perveived Control on the Purchase Intention of Bio-CNG Renewable Energy (A Case Study of Restaurants in Mataram City). Thesis, IPB University, Bogor, ID, 2023.
30. Zakia; Agustina, D.; Dewi, M.P.; Ismowati, M.; Vikaliana, R.; Saputra, M. Mewujudkan Sistem Pengelolaan Sampah Melalui Program Citarum Harum. *J Komunitas: J Pengabdi Kpd Masy.* **2019**, *1*, 38–43, doi:10.31334/jks.v2i1.291.
31. Karnowati, N.B.; Yuwono, D.T.; Tinggi, S.; Ekonomi, I.; Cilacap, M. Identifikasi Faktor Eksternal Terhadap Peran Masyarakat Dalam Pengelolaan Sampah Plastik Pantai Teluk Penyu Cilacap. *J Ilmu Lingkungan*, **2022**, *21*, 522–533, doi:10.14710/jil.21.3.522-533.