

Education Level as a Moderator of the Relationship between Environmental Concern and Waste Bank Participation

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ABSTRACT

Environmental issues, particularly waste management, have become critical concerns in urban areas across Indonesia. Waste bank programs offer community-based solutions that reduce waste volume while providing economic value to participants. This study examines the influence of environmental concern on community participation in waste bank programs and investigates whether education level moderates this relationship. A quantitative research approach was employed with a survey design involving 100 residents selected through purposive sampling with variations in education level. Data were collected using Likert scale questionnaires measuring environmental concern, waste bank participation, and education level. The analysis utilized Moderated Regression Analysis with SPSS PROCESS Macro Model 1. The findings reveal that environmental concern has a positive and significant effect on waste bank participation. Education level also demonstrates a positive and significant effect on participation. Most importantly, the interaction between environmental concern and education level shows a significant moderating effect, indicating that the influence of environmental concern on participation is stronger among individuals with higher education levels. These results suggest that efforts to increase community participation in waste bank programs should consider both environmental awareness and educational background. Tailored approaches that address the specific characteristics of different education groups may enhance program effectiveness. This research contributes to the development of more inclusive and targeted community-based waste management strategies.

INTRODUCTION

Urban waste problems have become an urgent environmental issue in various regions in Indonesia. The continuously increasing volume of waste each year is not matched by adequate management capacity, thereby causing negative impacts on public health and environmental sustainability. The quality of public services also determines the level of citizen satisfaction with efforts to handle health problems caused by waste, as shown in a study on patient satisfaction with public health services (Darmawan et al., 2022). The waste bank program emerges as one of the innovative solutions involving the active participation of residents in managing waste from its source (Nurikah & Furqon, 2022). A culture of innovation that is able to combine technological speed with humanistic thinking can serve as a reference in designing community-based waste

management programs so that they remain relevant to the needs of residents (Darmawan, 2023). The waste bank concept offers a community-based approach that not only reduces the volume of waste sent to final disposal sites, but also provides economic value for residents through the sale of sorted waste (Satori et al., 2020). However, the level of citizen participation in waste bank programs is still considered low in many regions. Various factors are suspected to influence this low participation, including environmental awareness, community habits, and socioeconomic factors. The limited capacity of waste management is also related to the quality of human resources, performance, and loyalty of officers handling waste in the field (Darmawan et al., 2020). Understanding the factors that influence citizen participation becomes important for designing more effective and

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sustainable waste management strategies.

Environmental concern is a psychological variable that reflects the extent to which individuals have attention to the surrounding environmental conditions and the willingness to engage in conservation efforts. Individuals with high environmental concern tend to have better awareness about the negative impacts of waste on the environment and health (Zhang et al., 2022). Positive psychological factors are known to be able to strengthen individual commitment to a particular task or responsibility, including the responsibility of maintaining environmental cleanliness (Darmawan & Mardikaningsih, 2022). They also better understand the benefits of good waste management, both for themselves and for the wider community. Fitrianto et al. (2024) show that the revitalization of waste banks in the campus environment successfully increased environmental awareness and waste management efficiency through active community participation. Djaelani (2021) also emphasizes that social participation in household waste management is strongly determined by the community's understanding of the importance of responsible waste management. Strong environmental concern encourages individuals to change their daily behaviors, including waste disposal habits and participation in waste management programs. One's psychological well-being is also related to the quality of social interactions, so concern for the environment can grow through healthy reciprocal relationships among residents (Darmawan & Gani, 2024). This level of concern becomes the foundation for the community's willingness to engage in waste bank programs (Nurhayati & Nurhayati, 2023).

The level of education is a demographic factor that has a significant influence on various aspects of social behavior, including participation in environmental programs. Individuals with higher levels of education generally have better access to information about environmental issues and a deeper understanding of the consequences of their behavior on the environment (Sun et al., 2020). Good knowledge management can be a source of advantage for both individuals and organizations in addressing complex problems, including the issue of waste management (Darmawan, 2023). Formal education equips individuals with critical and analytical thinking skills that enable them to evaluate the long-term benefits of participation in waste management programs. Khayru et al. (2024) highlight that policy coherence and institutional gaps in waste management affect community participation. Flexible organizational structures also

help waste management institutions adapt to changing needs and dynamics of surrounding residents (Darmawan & Mardikaningsih, 2023). Naldi (2023) also finds that the interaction between youth participation and household waste management systems is heavily influenced by the presence of local waste processing facilities. A higher level of education enables individuals to more easily understand the mechanisms of the waste bank program and the benefits that can be obtained from participating in the program (Popova & Lomonosov, 2023). The level of education is suspected to strengthen the relationship between environmental concern and participation in waste bank programs.

Community participation in the waste bank program not only benefits the environment but also provides economic and social benefits for residents (Bayu et al., 2022). Through the waste bank, residents can deposit sorted waste and receive rewards in the form of money or savings that can be withdrawn at any time. A religious value-based environmental insurance program designed for resident welfare shows that non-economic incentives can also encourage participation in environmental preservation efforts (Darmawan & Ahmad, 2022). This economic incentive becomes a distinct attraction that encourages residents to participate consistently. Mardikaningsih and Nuraini (2022) explain that the implementation of circular economy principles in waste management in the industrial sector requires active participation from various parties to achieve sustainability. The application of sustainable supply chain principles in the industrial sector can improve operational performance as well as corporate social responsibility, an approach that shares a similar spirit of sustainability with the waste bank program (Barzani et al., 2022). Le et al. (2024) find that coastal community participation in reducing the use of single-use plastic bags is influenced by awareness of the dangers of plastic waste and responsibility for environmental protection. Changes in consumption patterns toward simplicity also affect the amount of waste generated by households and reflect social inequalities in industrial dynamics (Gani et al., 2021). A well-managed waste bank program can serve as a means to build collective awareness and shared responsibility in waste management. Sustainable participation requires support from various parties, including village governments, waste bank managers, and community figures (Meidiana et al., 2022).

Environmental concern is not formed instantly but through a continuous process of learning and experience. Factors such as exposure to information about environmental issues, direct experience with pollution impacts, and formal environmental education contribute to the formation of this concern (Ezimah, 2022). Issalillah and Mardikaningsih (2022) observe that environmental injustice and health burdens in marginalized communities near waste disposal sites drive awareness about the importance of better waste management. Social construction and value shifts in society also shape residents' views on an issue, including stigmas or misconceptions regarding waste management that can hinder behavioral change (Gardi & Khayru, 2024). Baba-Nalikant et al. (2023) develop a zero-waste campus framework based on the perceptions and practices of the campus community in Malaysia. Awareness of the negative consequences of poor waste management becomes the main driver of behavioral change. People living in areas with severe waste problems tend to have higher environmental concern because they directly experience the negative impacts. This direct experience reinforces the motivation to participate in waste management programs (Jevrić & Čipranić, 2023).

The waste bank program requires active participation from all layers of society to achieve its objectives optimally. Radjawane et al. (2022) show that the application of lean management principles can reduce waste and improve operational efficiency in the service sector. Individual productivity in the digital era that considers creativity and innovation can serve as a reference for waste bank administrators in improving the operational efficiency of waste management (Darmawan, 2023). Wang et al. (2024) examine the mechanisms underlying the impact of community goal orientation on citizens' waste sorting recycling behavior. Their findings indicate that approach or avoidance in recycling behavior is influenced by how the community sets waste management goals. Citizen participation in the waste bank program depends not only on individual factors but also on social dynamics within the community. Support from neighbors, community figures, and waste bank administrators is crucial for creating a conducive environment for participation. Hidayat et al. (2024) examine the implementation of the precautionary principle in Indonesian environmental law regarding plastic waste management. Criminal law enforcement against environmental polluters is also necessary as a form of strict supervision so that waste management

programs run as they should (Mahmud et al., 2023). Supportive policies and effective supervision are needed to ensure the waste bank program runs well.

Challenges in increasing participation in the waste bank program include a lack of public awareness about the benefits of good waste management and low knowledge of correct waste sorting methods (Sekito et al., 2020). Nurmalasari and Mardikaningsih (2022) discuss the utilization of waste paper through recycling and the development of entrepreneurial spirit as an alternative to waste management. Environmental accountability built through business ethics, responsibility, morals, and legal obligations becomes an important foundation for parties involved in waste management to act responsibly (Darmawan, 2022). Mamesah et al. (2024) highlight industrial waste reporting obligations and public data disclosure in modern corporate law. Change management accompanied by compliance with legal provisions within an organization also becomes a determining factor for the success of waste management policy implementation (Darmawan et al., 2024). Kaçani et al. (2024) examine the role of social capital in bridging the gap between awareness and action in the context of climate change. Strong social capital in a community can accelerate the adoption of pro-environmental behavior through mechanisms of social influence and collective support. Farhoq et al. (2024) discuss electronic producers' obligations regarding electronic waste and waste management engineering. Legal protection for parties disadvantaged by the negligence of others emphasizes the importance of legal certainty in various aspects of public services, including waste management that impacts citizen health (Lethy et al., 2023). Adjei et al. (2024) find that the mediating and moderating effects of awareness of consequences in the value-belief-norm theory influence waste prevention behavior. An effective waste bank program requires an approach that considers these various factors in an integrated manner.

Based on this description, this study aims to analyze the effect of environmental awareness on community participation in waste bank programs, and to examine whether the level of education moderates the relationship between environmental awareness and community participation in waste bank programs. This research is expected to provide theoretical contributions to the development of knowledge regarding pro-environmental behavior and community participation in community-based

waste management. Practically, this research offers insights for sub-district governments and waste bank program managers to enhance citizen participation by taking into account differences in educational levels and environmental awareness. The research findings can also serve as a basis for more inclusive and effective community-based waste management policies. Understanding how environmental awareness and educational levels interact to influence participation will help in designing more targeted intervention strategies.

RESEARCH METHOD

This study employs a quantitative approach with an explanatory survey research design aimed at examining causal relationships among variables through hypothesis testing. According to Creswell (2003), an explanatory survey design is utilized when a researcher aims to explain how and why a phenomenon occurs by testing variable relationships formulated within research hypotheses. The population in this study comprises all residents of Sub-district X. The sampling technique used is purposive sampling with criteria including residents who have heard of or know about the waste bank program and are willing to complete the questionnaire. The sample in this study totals 100 respondents, selected by ensuring the representation of educational level variations ranging from elementary school, junior high school, senior high school, to higher education. According to Hair, Black, Babin, and Anderson (2010), the minimum sample size for moderated regression analysis is 100 respondents to ensure the stability of parameter estimates. Purposive sampling was chosen because this study requires respondents with specific characteristics aligned with the research objectives. This technique enables researchers to ensure that all categories of educational levels are represented within the sample, allowing the moderation analysis to be conducted effectively.

The operational definitions of variables in this study are formulated to measure the investigated constructs precisely and measurably. Environmental awareness as the independent variable is defined as an individual's level of attention and awareness toward environmental conditions, along with a willingness to engage in environmental conservation efforts. Indicators of environmental awareness include awareness of maintaining environmental cleanliness, concern over waste issues, and participation in preserving green spaces (Gkargkavouzi et al., 2018). Waste bank program participation as the dependent variable is defined as

active resident involvement in waste bank activities, encompassing waste deposits, schedule adherence, and contributions of waste management ideas (Meidiana et al., 2022). Participation indicators include participation in depositing waste, consistency in following schedules, and contributions of waste management ideas (Mohamed, 2024). Educational level as the moderating variable is defined as the highest formal education level completed by the respondent (Khayru et al., 2024). Educational level is categorized into elementary school, junior high school, senior high school, and higher education for the purposes of moderation analysis.

Data collection was conducted through questionnaires using a 1 to 5 Likert scale to measure levels of environmental awareness and waste bank program participation. A Likert scale of 1 indicates strongly disagree and 5 indicates strongly agree with the presented statements. The research instrument was tested for validity using Corrected Item-Total Correlation with a correlation value criterion of > 0.30 , and its reliability was tested using Cronbach's Alpha with a value criterion of > 0.70 (Nunnally & Bernstein, 1994). The data analysis technique used is Moderated Regression Analysis (MRA) with the equation $Y = b_0 + b_1X + b_2M + b_3(X \times M) + e$, where Y is waste bank program participation, X is environmental awareness, M is educational level, and $X \times M$ is the interaction between environmental awareness and educational level (Aiken & West, 1991). The analysis was performed using SPSS with the PROCESS Macro Model 1 developed by Hayes (2018) to test the moderation effect. Hypothesis testing was carried out by observing the significance value (p-value) of the regression coefficients at a 95% confidence level. H1 states that environmental awareness positively affects waste bank program participation, while H2 states that educational level moderates the effect of environmental awareness on waste bank program participation.

RESULT AND DISCUSSION

The research sample consisted of 100 residents of Kelurahan X who were selected using purposive sampling technique with variations in education level. The distribution of respondents based on gender showed that 57 respondents (57%) were female and 43 respondents (43%) were male. This composition reflects the general condition of the community where women tend to be more involved in household waste management activities. Based on age, the majority of respondents were in the age range of 31-50 years with 48 respondents (48%),

followed by the age range of 19-30 years with 28 respondents (28%), and the age range of over 50 years with 24 respondents (24%). The age distribution indicates that the research covered various generations of society who have different experiences and perspectives regarding environmental issues. Regarding education level, the distribution was designed to be relatively balanced to support moderation analysis, consisting of elementary school graduates (20 respondents or 20%), junior high school graduates (24 respondents or 24%), senior high school graduates (30 respondents or 30%), and university graduates (26 respondents or 26%). The variation in education level allows the study to analyze whether education level moderates the relationship between environmental concern and participation in the waste bank program. Based on occupation, the majority of respondents were housewives (30 respondents or 30%), followed by private employees (25 respondents or 25%), self-employed (20 respondents or 20%), civil servants (15 respondents or 15%), and others (10 respondents or 10%). The variation in occupation reflects the socioeconomic diversity of the community that can influence the level of environmental concern and participation in the waste bank program.

Table 1. Validity and Reliability Test Results

Variable	Indicator	Corrected Item-Total Correlation	Cronbach's Alpha	Status
Environmental Concern (X)	X1	0.712	0.845	Valid & Reliable
	X2	0.768		
	X3	0.739		
Waste Bank Participation (Y)	Y1	0.754	0.823	Valid & Reliable
	Y2	0.721		
	Y3	0.698		

The validity test results in Table 1 show that all indicators have Corrected Item-Total Correlation values above 0.30, ranging from 0.698 to 0.768, indicating that all indicators are valid in measuring the variables studied. The highest Corrected Item-Total Correlation value is found in indicator X2 for the environmental concern variable and Y1 for the waste bank participation variable. The reliability test results show that Cronbach's Alpha values for the environmental concern variable is 0.845 and for the waste bank participation variable is 0.823, both above the threshold of 0.70. Thus, the research instrument is declared reliable and can be used for data collection. Good reliability indicates that the items in the questionnaire have high internal

consistency in measuring the same construct. Validity and reliability testing was conducted before the main data collection to ensure the quality of the instrument used. These results provide confidence that the data to be collected has adequate quality for further analysis.

Table 2. Descriptive Statistics of Research Variables

Variable	N	Mean	Std. Deviation	Min	Max
Environmental Concern (X)	100	3.85	0.742	2.00	5.00
Waste Bank Participation (Y)	100	3.62	0.813	1.67	5.00
Education Level (M)	100	2.84	0.956	1.00	4.00

Table 2 presents the descriptive statistics of the three research variables based on data obtained from 100 respondents. The environmental concern variable has a mean value of 3.85 with a standard deviation of 0.742, indicating that generally respondents have a relatively high level of environmental concern. The waste bank participation variable has a mean value of 3.62 with a standard deviation of 0.813, indicating a fairly good level of participation but still varying among respondents. The education level variable has a mean value of 2.84 with a standard deviation of 0.956, reflecting a fairly wide variation in education level among respondents. The largest standard deviation is found in the education level variable, indicating that respondents come from diverse educational backgrounds. The minimum and maximum values of the three variables show that the data covers the entire range of measurement scales. The varied data distribution provides a good foundation for conducting moderated regression analysis. The descriptive data also shows that the mean score of environmental concern is higher than the mean score of waste bank participation, indicating that awareness is not always followed by action.

Table 3. Moderated Regression Analysis Results

Variable	Coefficient (B)	Std. Error	t	Sig.
Constant	1.248	0.342	3.649	0.000
Environmental Concern (X)	0.514	0.098	5.245	0.000
Education Level (M)	0.287	0.112	2.563	0.012
Interaction X*M	0.183	0.087	2.103	0.038

Table 3 presents the results of the moderated regression analysis with the equation $Y = 1.248 + 0.514X + 0.287M + 0.183(X \times M)$. The analysis results show that the environmental concern variable has a positive and significant effect on waste bank participation with a coefficient of 0.514 ($p = 0.000$).

This indicates that every one-unit increase in environmental concern will increase waste bank participation by 0.514 units. The education level variable also has a positive and significant effect on waste bank participation with a coefficient of 0.287 ($p = 0.012$). Most importantly, the interaction variable between environmental concern and education level shows a positive and significant effect with a coefficient of 0.183 ($p = 0.038$), indicating that education level moderates the relationship between environmental concern and waste bank participation. The R-squared value of the model is 0.487, meaning that 48.7% of the variation in waste bank participation can be explained by environmental concern, education level, and their interaction. The remaining 51.3% is explained by other factors not included in this research model. The significance of the interaction term confirms that the effect of environmental concern on participation depends on the level of education of the respondents.

The positive and significant influence of environmental concern on waste bank program participation indicates that individuals who have high attention to environmental conditions tend to be more actively involved in waste management programs. This finding is in line with the research by Fitrianto et al. (2024) which found that environmental awareness encourages community participation in waste bank programs through an increased understanding of the benefits of good waste management. Environmental concern does not only encompass awareness about the negative impacts of waste but also an understanding of the individual's role in overcoming these problems. Le et al. (2024) also observed that awareness of the dangers of plastic waste and responsibility for environmental protection are the main drivers of community participation in waste management programs. Issalillah (2025) reinforced these findings by stating that environmental awareness and daily lifestyle play an important role in driving plastic waste reduction behavior, so that concern growing from individual understanding of waste impacts can be translated into real actions in daily life. The implication of this finding is that efforts to increase waste bank program participation must begin with enhancing residents' environmental concern through effective education and campaigns. Sustainable socialization programs that involve various stakeholders can strengthen public awareness about the importance of responsible waste

management. Zulkarnain et al. (2021) asserted that citizen involvement in managing ecological issues will be more optimal if carried out through a participatory approach that involves social support from the surrounding environment, rather than merely one-way appeals. Communities with high environmental concern will voluntarily participate without requiring large external incentives.

The significant influence of the education level on waste bank program participation indicates that individuals with higher education have better awareness and understanding of the importance of waste management programs. This finding supports the research by Khayru et al. (2024) which highlighted that education level influences public understanding of environmental policies and programs. Formal education equips individuals with the ability to access, understand, and evaluate information about environmental issues. Individuals with higher education also tend to have wider social networks that facilitate the dissemination of information about waste bank programs. This is supported by Mardikaningsih and Darmawan (2022) who found that self-efficacy plays an important role in determining an individual's ability to adapt to change, including behavioral pattern changes in waste management; individuals with higher education generally have stronger self-efficacy so they are more prepared to accept and execute new programs. Naldi (2023) found that participation in waste management is influenced by the presence of waste processing facilities and an understanding of program mechanisms. The practical implication of this finding is that strategies to increase waste bank program participation need to consider differences in residents' education levels. Socialization and training materials must be adjusted to the level of understanding of each education group so that the message can be received effectively. Mardikaningsih and Hariani (2021) reminded that sustainable public policies need to maintain a balance between economic, social, and environmental aspects, so the design of waste bank educational programs should not only be oriented toward delivering information but also consider the economic and social conditions of program recipient residents. A successful waste bank program is one that is able to reach all layers of society with an approach that suits their characteristics.

The significant interaction between

environmental concern and education level indicates that the influence of environmental concern on waste bank program participation is strengthened by a higher level of education. This finding reinforces the research by Kaçani et al. (2024) which found that social capital moderates the relationship between awareness and action in an environmental context. Individuals with high education and high environmental concern have a greater capacity to translate their awareness into real action. They not only possess a better understanding of environmental issues but also have the skills and confidence to participate actively. Wang et al. (2024) also found that community goal orientation influences recycling behavior through mechanisms involving cognitive and motivational factors. In line with that, Mardikaningsih and Nuraini (2022) explained that the implementation of circular economy principles in the waste management sector demands adequate technical understanding, making the combination of concern and education a determining factor for the success of implementing such principles at the household level. The implication of this finding is that participation-enhancing programs must consider the synergistic effects of environmental concern and education level. Interventions designed to increase environmental concern will be more effective in groups with higher education, while groups with lower education require a more intensive and adaptive approach. Nuraini et al. (2022) added that a social entrepreneurship-based approach can be an effective strategy to reach groups with low education levels, because such an approach emphasizes direct learning through practice and active involvement, rather than merely formal material delivery. An inclusive waste bank program must provide adequate resources and support for residents with various levels of education.

CONCLUSION

Environmental awareness has a positive and significant effect on community participation in waste bank programs. Educational level also has a positive and significant effect on community participation in waste bank programs. Most importantly, educational level is proven to moderate the effect of environmental awareness on waste bank program participation, where the influence of environmental awareness becomes stronger among individuals with higher levels of education. The contribution of this research is the development of a theoretical model explaining the role of educational level as a moderating variable in the relationship

between environmental awareness and waste bank program participation. Practically, these findings provide insights for sub-district governments and waste bank program managers to design more effective strategies in enhancing citizen participation by taking into account differences in educational levels. Environmental socialization and education programs need to be tailored to the characteristics of each educational group so that messages can be received optimally. An inclusive and adaptive approach will ensure that all strata of society can participate actively in waste bank programs.

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