

## Logistic Regression Analysis for Uncovering Socio-demographic Factors of Community Participation in Waste Management

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### Abstract

This study presents the results of a preliminary attempt to assess community acceptance in an Indonesian village where a community-based waste management program is economically more attractive than simply burning or burying the waste. In Karang Village, Bojonegoro, domestic waste is mostly burnt or buried, contributing to environmental degradation, such as water, soil, and air pollution caused by smoke. Regression analysis was applied to calculate and analyze the data. Photo mapping on current waste management (WM) practices was provided beforehand to identify its effect on the environment. The study indicates that there were about 18 illegal dumping sites in the village, which are frequently open-burnt by villagers, emitting odor and smoke, deteriorating the air quality. Low community participation in rural waste management, only 56.6%, causes improper WM. The study emphasizes the significant role of individual characteristics, age, education, motivation, opinion, willingness to be involved, sense of responsibility, information about 3R and 3R counseling, availability on dissemination, and training on waste management in influencing individuals' participation in community activities.

**Keywords:** rural waste management, waste reduction

### INTRODUCTION

Waste management (WM) issues are the main concern to be addressed to mitigate its effect on several aspects worldwide, especially in developing countries, which are more susceptible to the effects that have been confirmed, such as water and soil pollution. These countries face potential challenges caused by increasing waste generation caused by population growth, urbanization, and economic development [1] [2]. Increasing waste generation without good WM could be harmful to human well-being. Inadequate waste disposal procedures, poor financial schemes, and political interference contribute to environmental threats due to insufficient infrastructure, low collection coverage, and weak financial schemes. [3]. Previous studies highlighted other factors, such as insufficient regulation of secondary material resources, inadequate extended producer responsibility (EPR) procedures, and no prohibition on disposal and non-recyclable plastic products [4].

Improvement of infrastructure, process efficiency, and public awareness increase are challenges for the implementation of sustainable WM [5], including the necessity of efficient waste collection, environmentally friendly disposal systems, and waste-to-energy (WtE) conversion [6]. Some studies addressing these issues were conducted for WM system improvement, including community empowerment, because sustainable WM requires public participation. This participation may improve environmental governance, enhance WM infrastructure, and increase the community's willingness to participate [7].

Community participation decisions are influenced by home ownership, social status, age, health, education, household size, and income [8]. Study [9] [10] [11] also identified other factors, i.e., the intensity of social life with neighbors, WM performance knowledge, behavior, attitude toward waste management, access to recycling facilities, regulations, technical experience, perception of benefits, environmental awareness, sense of responsibility, understanding of social norms and regulations, environmental value and motivation

Community participation in WM brings benefits individually and socially. [12] found that employing a community composting plant reduced carbon footprint compared to landfill or incinerator methods. The other study from [13]

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revealed decreasing garbage quantity in areas where their communities are involved in anti-litter monitors' training initiatives. At the same time, [14] found that increasing the community's knowledge and awareness of the threats of environmental and health risks caused by inappropriate waste disposal positively correlates with community participation.

In developing countries, community participation in WM is acknowledged as an important factor for successful waste management [15]. However, community participation in WM is secondary there. [16] She gave an example in her study in Solwezi, Zambia, where only 35% of people participated in formal WM practices. Meanwhile, a study in Jakarta, Indonesia, found hindrances to participatory processes in waste management [17]. Despite these challenges, community engagement in waste management is increasingly recognized, leading to the adaptation of participatory methodologies to local circumstances and stakeholder involvement. [18].

In rural areas, community participation is important for efficient WM as well as the role of the informal waste sector. Informal WM practices in rural areas are established due to the need for formal WM systems. Examples are community-based recycling facilities and waste banks, which should be supported by adequate community participation for effective WM. Effective WM practices in rural areas can transform waste into valuable resources and generate economic benefits. [19]. Previous studies have been focused on selecting appropriate treatment facilities for improving rural WM. [20] since inferior waste services in rural areas often result in environmentally harmful methods, such as open-dumping and burning [21] [22]. Proper waste treatment alternatives for better rural WM are available, i.e., composting and anaerobic digestion for organic waste or waste reduction through a waste bank (WB) for recyclable materials. Despite their potential benefits, these methods are not widely adopted in developing nations due to infrastructural limitations and governance issues. [23]. Implementing sustainable waste management practices in rural areas offers benefits that enhance the environment, health, and local economies.

Considering the potential of community participation on the one hand and the current waste management issues in Indonesian rural areas on the other hand, the study aims to analyze the determinants influencing individuals

to participate in rural waste management programs. The study is located in Karang Village, Bojonegoro Regency, Indonesia. Currently, Bojonegoro has 2 landfills (LFs), namely Banjarsari LF and Bandungrejo LF, with a capacity of 34,440 m<sup>3</sup> and 210,000 m<sup>3</sup>, respectively. Both landfills are expected to be overloaded within the next 5 years—low waste reduction and treatment rate cause this situation where LF has a shorter duration than was planned. Waste reduction has been implemented in Temporary Shelters (TPS), but less than 10 out of 54 TPS. Furthermore, the 170 Waste Banks (WBs) performance is low, with the reduction capacity being about 7% of the total waste generated in Bojonegoro. In Karang Village, there was one WB, but now it is inactive due to a low number of customers. People are not willing to participate in waste reduction through the benefits offered. Currently, people sort the waste for reuse, but most is burnt or buried in the backyard. The practices may contribute to public health risks. The identified factors in participation decision-making are crucial to be found out to improve the rural WM in Karang Village, especially by encouraging people to reduce waste through WB. The results of this study can contribute to problem-solving in WM problems that are to be considered by the local government and relevant agencies.

## **MATERIAL AND METHOD**

### **Research Design**

This study used a quantitative research approach to investigate the factors influencing participation decision-making in Karang Village, Bojonegoro Regency. A cross-sectional design is applied in this research for data collection using a sample of households (HHs) the village.

### **Study Setting**

Karang Village has a population of 3.348 and is located north of Bojonegoro Regency. In 2020, the local government introduced a rural waste management program by establishing one waste bank (WB), and the community was advised to be its customer to get acquainted with waste separation and reduction while they have the possibility for income generation by selling waste to WB. However, the number of HHs being the WB's customers remains constant (20 HHs) until 2023. In 2024, the WB will be closed due to inactive members. Only a small amount of recyclable material was brought to the WB. Generally, the village lacks basic waste

management infrastructure such as waste collection and treatment. Waste is commonly openly burnt or buried in the backyard. Identifying the determinants of community participation in waste reduction through WB is critical to addressing the underlying issues and improving waste management practices in the village.

**Sampling**

The study utilized a convenience sampling technique for sample selection comprising 134 HHs dispersed in 4 hamlets in Karang Village with various social and economic backgrounds, as presented in Table 1. Samples were collected through door-to-door visits, and those who satisfied the inclusion criteria were offered to participate in the study willingly.

**Table 1** Sample Proportion

| Hamlet       | # of HHs   | %          | # of samples |
|--------------|------------|------------|--------------|
| Karangan     | 231        | 24.5       | 33           |
| Pojok        | 162        | 17.2       | 23           |
| Tulung       | 375        | 39.7       | 54           |
| Paloh        | 176        | 18.6       | 26           |
| <b>Total</b> | <b>944</b> | <b>100</b> | <b>136</b>   |

**Data Collection**

Primary data was collected by distributing questionnaires to the samples conducted from July 2023 to September 2023. A research assistant managed the questionnaire through face-to-face contact with HHs. The questionnaire was developed based on the Theory of Planned Behavior (TPB) proposed by [24] and comprised items used in similar previous studies focusing on community participation in waste management.

The questionnaire was tested with some HHs beforehand to confirm the questions were straightforward. The data type is binary since it will use logistic regression. The dependent variable (Y) in this study is community participation in WB, X as independent variables are both internal factors (socio-demographic set, knowledge) and external factors (situational variables, psychological conditions). The description of the variables is shown in Table 2.

| Variables                                | Criteria                           | References            |
|--|------------------------------------|-----------------------|
| Age(X <sub>1</sub> )                     | 1 = 15-65 years old, 0 = otherwise | [25]                  |
| Education(X <sub>2</sub> )               | 1 = tertiary, 0 = < below tertiary | [25]; [26]            |
| Income(X <sub>3</sub> )*                 | 1 = > RMW, 0 = < RMW               | [27]                  |
| Social Status(X <sub>4</sub> )           | 1 = > leader, 0 = < otherwise      | [28]                  |
| Employment(X <sub>5</sub> )              | 1 = formal, 0 = informal           | [29]                  |
| Homeownership(X <sub>6</sub> )           | 1 = nuclear, 0 = extended          | [30]; [31];[32]; [33] |
| Waste bin (at home) (X <sub>7</sub> )    | 1 = available, 0 = not available   | [30]                  |
| Knowledge about                          | 1 = have, 0 = don't have           | [31]                  |
| a. Environmental issues(X <sub>8</sub> ) |                                    |                       |
| b. Waste Production(X <sub>9</sub> )     |                                    |                       |
| c. Waste Problems(X <sub>10</sub> )      |                                    |                       |
| d. Waste Programs(X <sub>11</sub> )      |                                    |                       |
| Psychological reason                     | 1 = agree, 0 = disagree            | [34]                  |
| a. Attention to Waste(X <sub>12</sub> )  |                                    |                       |
| b. Motivation(X <sub>13</sub> )          |                                    |                       |
| c. Opinion (X <sub>14</sub> )            |                                    |                       |
| d. Subjective norm(X <sub>15</sub> )     |                                    |                       |
| e. Willingness to Act(X <sub>16</sub> )  |                                    |                       |
| f. Sense of Belonging(X <sub>17</sub> )  |                                    |                       |
| Source of Knowledge (X <sub>18</sub> )   | 1 = > 1 source, 0 = only 1 source  | [35]                  |
| Recipient of 3R                          | 1 = have received, 0 = never       | [26]                  |
| a. Information(X <sub>19</sub> )         |                                    |                       |

|                                     |                         |
|-------------------------------------|-------------------------|
| b. Dissemination(X <sub>20</sub> )  | 1 = agree, 0 = disagree |
| Cadres have role (X <sub>21</sub> ) |                         |

**Table 2.** Variables for the analysis

\*Regional Minimum Wage in Bojonegoro was Rp. 2.279.568 in 2023

**Data Analysis**

The collected data was analyzed through a set of statistical methods. Descriptive statistics such as mean and frequency distribution were used to describe the samples' demographic characteristics and the variables. The study hypotheses were tested using logistic regression analysis, and the significance level was set at p < 0.05.

**Validity and Reliability**

Construct validity was assessed by examining the relationship between the different variables in the questionnaire [36]. Logistic regression analysis given by [37] was used to assess the expected associations between the variables. It is a model for binary variable where the response records either success or failure for a given event. Eq 1 is used to estimate the participation decision making

$$p_1 = \beta_0 + \beta_1 \text{AGE}(X_1) + \beta_2 \text{EDUCATION}(X_2) + \beta_3 \text{HOMEOWNERSHIP}(X_3) + \dots + \beta_{21} \text{CADRES ROLE}(X_{21}) \quad (1)$$

Logistics regression analysis involves multiple tests to evaluate the fitted model's utility, convenience, and sufficiency. The significance of each independent variable is assessed by examining the coefficients' significance. An investigation of the goodness of the model's fitness will proceed afterwards. These tests are conducted to ensure the validity and reliability of the research variables. Cronbach's alpha coefficient was used to check the internal consistency of the questionnaire. The variables are acceptable if the Cronbach's alpha coefficient is at least 0.6 for the study.

**RESULT AND DISCUSSION**

**Descriptive of variables**

The productive age is dominated by the age of 36 until 65, while the informal sector is the main livelihood in Karangan Village. The other results of variables used for regression are presented in Table 3.

**Table 3.** Descriptive of categorical variables

| Variable  | Category        | N   | %  | Variabel                               | Kategori      | N   | %  |
|---|-----------------|-----|----|--|---------------|-----|----|
| Age(X <sub>1</sub> )                                  | 19-35 years old | 33  | 24 | Source of Knowledge (X <sub>12</sub> ) | Only 1 Source | 62  | 46 |
|   | 36-65 years old | 103 | 76 |  | >1 Source     | 74  | 54 |
| Education(X <sub>2</sub> )                            | ≤secondary      | 37  | 27 | Attention to Waste(X <sub>13</sub> )   | Disagree      | 84  | 62 |
|   | >secondary      | 99  | 73 |  | Agree         | 52  | 38 |
| Income(X <sub>3</sub> )*                              | <RMW            | 63  | 46 | Motivation(X <sub>14</sub> )           | Disagree      | 79  | 58 |
|   | >RMW            | 73  | 54 |  | Agree         | 57  | 42 |
| Social Status(X <sub>4</sub> )                        | Other           | 78  | 57 | Subjective Norm(X <sub>15</sub> )      | Disagree      | 25  | 18 |
|   | Leader          | 58  | 43 |  | Agree         | 111 | 82 |
| Employment(X <sub>5</sub> )                           | Informal        | 98  | 72 | Opinion(X <sub>16</sub> )              | Disagree      | 53  | 39 |
|   | Formal          | 38  | 28 |  | Agree         | 83  | 61 |
| Homeownership(X <sub>6</sub> )                        | extended        | 12  | 9  | Willingness to Act (X <sub>17</sub> )  | Disagree      | 47  | 35 |
|   | Nuclear         | 124 | 91 |  | Agree         | 89  | 65 |
| Waste bin (at home)(X <sub>7</sub> )                  | Not available   | 81  | 60 | Sense of Belonging (X <sub>18</sub> )  | Disagree      | 43  | 32 |
|   | Available       | 55  | 40 |  | Agree         | 93  | 68 |
| Knowledge about environmental issues(X <sub>8</sub> ) | Don't Have      | 63  | 46 | Information of 3R (X <sub>19</sub> )   | Never         | 54  | 40 |
|   | Have            | 73  | 54 |  | Have          | 82  | 60 |
| Knowledge about Waste Production(X <sub>9</sub> )     | Don't Have      | 76  | 56 | Dissemination of 3R (X <sub>20</sub> ) | Received      |     |    |
|   | Have            | 60  | 44 |  | Never         | 101 | 74 |
| Knowledge about Waste Problems(X <sub>10</sub> )      | Don't Have      | 75  | 55 | Cadres have role (X <sub>21</sub> )    | Have          | 35  | 26 |
|   | Have            | 61  | 45 |  | Received      |     |    |
| Knowledge about Waste Programs(X <sub>11</sub> )      | Don't Have      | 43  | 32 |  | Disagree      | 131 | 96 |
|   | Have            | 93  | 68 |  | Agree         | 5   | 4  |

\* Regional Minimum Wage in Bojonegoro was Rp. 2.279.568 in 2023

**Empirical Findings**

Table 4 presents the community participation in 3R-related activities in Karangam Village. From Table 4, the involvement of HHs in waste management is conducted through reduction, reuse, or recycling in various percentages. In this study, recycling refers to segregating waste for sale to WB. Only 28.7% of samples reduce waste, with 56.6% of it implementing reuse or recycling.

**Table 4.** 3R-related activities in Karangam Village

| Activities       | Catagory | Frequency | (%)   |
|------------------|----------|-----------|-------|
| Reduction        | Yes      | 84        | 28.7% |
|                  | No       | 52        | 71.3% |
| Reuse or recycle | Yes      | 77        | 56.6  |
|                  | No       | 59        | 43.4  |

**Binary Logistic Regression Analysis**

The binary logistic regression model is used to perceive the related socio-demographic and psychological factors impacting the dependent variable. Using variables presented in Table 3, analysis was conducted to fit a binary logistic regression model.

The Goodness of Fit test is said to be fit if the *Sig value* is greater than the  $\alpha$  value (0.05). Table 5 observes the likelihood table for the Hosmer-Lemeshow test, while Table 6 displays the Hosmer–Lemeshow test result. Referring to Table 5, the Sig value of 0.525 is greater than the error value, and it is considered that the overall model fit is good. The Cronbach's Alpha value is 0.676, indicating a value higher than 0.6, meaning that

the questionnaire items are reliable for use (Table 6). Table 7 shows all the values of each variable. Variables with a significance value less than 0.05 are considered significant factors in the participation-decision-making of HHs in Karangam Village to participate in waste reduction through WB. There are nine variables with a significance value <0.05, indicating that these variables are the factors, i.e., age ( $X_1$ ), education ( $X_2$ ), knowledge of waste generation ( $X_9$ ), motivation ( $X_{14}$ ), opinion on waste problems ( $X_{16}$ ), willingness to get involved ( $X_{17}$ ), Sense of Belonging ( $X_{18}$ ), 3R information ( $X_{19}$ ), and 3R counseling ( $X_{20}$ ) are more likely to allow people to get involved in household waste management in Karangam Village. Referring to Eq 1. The model can be described as follows:

$$P_1 = -24.809 + 6.191X_1 + 8.473X_2 + 4.827X_9 + 7.196X_{14} + 5.221X_{16} + 7.515X_{17} + 13.922X_{18} + 5.058X_{19} + 9.048X_{20}$$

The model shows the R square value of 0.874, indicating that the independent variables' influence on community participation in decision-making for waste reduction through WB is 87%.

**Table 5.** Hosmer and Lemeshow Test

| Step | Chi-square | df | Sig. |
|------|------------|----|------|
| 1    | 7.108      | 8  | .525 |

**Table 6.** Reliability test

| Cronbach's Alpha | N of Items |
|------------------|------------|
| .676             | 21         |

**Table 7.** Variable in the Equation

| Variabel                                      | B       | S.E.      | Wald  | df | Sig.  | Exp (B) |
|---|---------|-----------|-------|----|-------|---------|
| Age( $X_1$ )                                  | 6.191   | 2.735     | 5.126 | 1  | 0.024 | 2.296   |
| Education( $X_2$ )                            | 8.473   | 3.819     | 4.922 | 1  | 0.027 | 2.684   |
| Income( $X_3$ )                               | -3.94   | 2.464     | 2.558 | 1  | 0.11  | 0       |
| Social status( $X_4$ )                        | 2.118   | 1.907     | 1.233 | 1  | 0.267 | 0.198   |
| Employment( $X_5$ )                           | 2.344   | 1.734     | 1.828 | 1  | 0.176 | 0.348   |
| Homeownership( $X_6$ )                        | -0.634  | 2.181     | 0.084 | 1  | 0.771 | 0.007   |
| Waste bin (at home)( $X_7$ )                  | 5.271   | 3.358     | 2.464 | 1  | 0.116 | 0.27    |
| Knowledge about Environmental issues( $X_8$ ) | -27.769 | 12096.602 | 0     | 1  | 0.998 | 0       |
| Knowledge about Waste Production( $X_9$ )     | 4.827   | 2.18      | 4.902 | 1  | 0.027 | 1.74    |
| Knowledge about Waste Problems( $X_{10}$ )    | -2.54   | 1.886     | 1.815 | 1  | 0.178 | 0.002   |
| Knowledge about Waste Programs( $X_{11}$ )    | 4.888   | 2.535     | 3.718 | 1  | 0.054 | 0.923   |
| Source of Knowledge( $X_{12}$ )               | 19.802  | 12096.602 | 0     | 1  | 0.999 | 0       |
| Attention to Waste( $X_{13}$ )                | 1.969   | 2.541     | 0.6   | 1  | 0.438 | 0.049   |
| Motivation( $X_{14}$ )                        | 7.196   | 3.455     | 4.338 | 1  | 0.037 | 1.529   |
| Subjective norm( $X_{15}$ )                   | 3.59    | 2.62      | 1.877 | 1  | 0.171 | 0.213   |
| Opinion( $X_{16}$ )                           | 5.221   | 2.595     | 4.048 | 1  | 0.044 | 1.145   |
| Willingness to Involve( $X_{17}$ )            | 7.515   | 3.291     | 5.212 | 1  | 0.022 | 2.896   |

| Variabel                                     | B       | S.E.   | Wald  | df | Sig.  | Exp (B) |
|--|---------|--------|-------|----|-------|---------|
| Sense of Belonging(X <sub>18</sub> )         | 13.922  | 6.561  | 4.503 | 1  | 0.034 | 2.986   |
| Recipient of Information(X <sub>19</sub> )   | 5.058   | 2.535  | 3.98  | 1  | 0.046 | 1.093   |
| Recipient of Dissemination(X <sub>20</sub> ) | 9.048   | 4.344  | 4.339 | 1  | 0.037 | 1.707   |
| Cadres have role(X <sub>21</sub> )           | 6.893   | 4.883  | 1.992 | 1  | 0.158 | 0.069   |
| Constant                                     | -24.809 | 10.296 | 5.807 | 1  | 0.016 | 0       |

Table 8. Summary model

| -2 Log likelihood   | Cox & Snell R Square | Nagelkerke R Square |
|---------------------|----------------------|---------------------|
| 42.680 <sup>a</sup> | .652                 | .874                |

**CONCLUSION**

Karangan Village community household waste management in Karangan village includes waste reduction and handling is quite active; this can be seen from the number of active respondents, as many as 77 people or 56.6%, and 59 or 43.4% are involved in passive waste management, Based on 21 independent variables that were analyzed for their influence on the dependent variable in the form of community involvement in household waste management through logistic regression, there were 9 variables having significant influence, i.e. age, education, knowledge of waste generation, motivation, opinion on waste problems, willingness to get involved, sense of responsibility in waste management, 3R information, and 3R dissemination.

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