Factors affecting community participation in the waste bank in sukoharjo regency: implications for circular economy

Lusia Dara Sari, *Sri* Marwanti, and *Umi* Barokah*,

Study Program of Agribusiness, Faculty of Agriculture, Universitas Sebelas Maret, Jl. Ir. Sutami 36A, 57126, Surakarta, Indonesia

Abstract. Waste management is a challenge in various regions, such as Sukoharjo Regency, where waste generation reached 361.92 tons per day in 2022. One approach to addressing this issue is the establishment of waste banks. Waste banks engage in activities such as buying, selling, and processing waste, which are all part of the circular economy concept. The success of waste bank operations depends on community participation. This study aims to identify the factors influencing community participation in waste bank programs and to determine the relationship between participation and the circular economy. This research used binary logistic regression analysis and causal loop diagram (CLD) modeling. The results indicate that the variables of knowledge and socialization related to waste significantly affect community participation. The CLD model illustrates that the relationship between socialization and knowledge is mutually "reinforcing," while the relationship between socialization, knowledge, participation, and the circular economy is "balancing." These findings highlight the importance of improving waste-related knowledge through regular and effective socialization efforts. The increase in participation in waste bank activities will boost the amount of waste processed and have the potential to be integrated with other sectors.

1 Introduction

Waste is defined as material that has no value, is damaged, defective, residual, or excess [1]. The management of waste is a crucial issue that must be addressed in every region, including Sukoharjo Regency. The daily waste generation reaches 361.92 tons each day, with a total of 132,101.09 tons in 2022. The amount of waste generated, both annually and daily, has remained stable from 2019 to 2022. This waste consists of both organic and inorganic waste. Organic waste includes food scraps, wood, and shells, while inorganic waste includes plastic,

metal, and glass. Data from the National Waste Management Information System reveals that the largest portion of waste in Sukoharjo Regency is food waste, making up 60.8% of the total waste, while the smallest portion is glass waste, at 1.27%. Therefore, one of the solutions to reduce the amount of waste is to establish a waste bank.

A waste bank is an institution or organization whose main activity is to collect waste from the community. The waste collected is usually waste that still has economic value, such as plastic [2]. The working system of a waste bank involves sorting, weighing, and selling the waste brought by customers to collectors or waste craft artisans, then giving or depositing the proceeds from the sale into the waste bank customer's account [3]. In addition to buying and selling waste, some waste banks are also equipped with 4R (*reduce, reuse, recycle, replace*) activities, such as recycling bottle caps into tables and processing organic waste into fertilizer. Recycling activities will have positive effects by reducing the amount of waste and decreasing the potential for producing new waste when manufacturing products.

The waste bank's adoption of the 4R approach is a part of implementing a circular economy. A circular economy is focused on reducing, reusing, and repairing materials throughout their life cycle in the production, distribution, and consumption processes [4,5]. Its primary aim is to establish a sustainable economy and enhance environmental quality. The waste bank program in Indonesia is an example of the circular economy in action. Implementing a circular economy through waste bank activities requires active community participation. Moreover, active community participation can play a role in implementing the sustainable development goals through waste reduction activities, both organic and inorganic.

The performance and active status of a waste bank are closely related to community awareness and participation [6]. The participation can take different forms such as decision-making, implementation, utilization, and evaluation [7,8]. The community can participate by contributing their labor, money, or goods. A simple form of community participation is waste collection. Active community participation will affect the continuity of waste bank programs, from sales transactions to waste processing. Without participation, waste cannot be collected, programs cannot be implemented, and the circular economy cannot be applied. This research aims to finds factors affecting the community participation on waste bank program in Sukoharjo Regency and its implication on circular economy.

2 Material and Method

2.1 Research Location

The research was conducted at waste banks in Sukoharjo Regency. The selected waste banks were those that conducted regular monthly activities and had established waste processing procedures. The research included three waste banks: Kopen Sae Waste Bank, Maju Lancar Bodeyan Waste Bank, and Bunga Raya Waste Bank.

2.2 Sampling Method

The sample in this research was determined using purposive sampling. The population are the members of waste banks in Sukoharjo Regency. The sample size was determined using a sample-to-variable ratio, with a minimum ratio of 5:1 [9]. However, this research used a 10:1 ratio. With five independent variables, the total sample size for this study was 50 samples.

2.3 Data Analysis Method

2.3.1 Factors Affecting Community Participations

This research used binary logistic regression to examine the relationship between the dependent variable (Y) and several independent variables. The dependent variable was a binary categorical variable (Y), where respondents were categorized as either active (1) or passive (0) based on their total scores [10]. The overall model fit test and a goodness of fit test conducted to determine whether the model and data were aligned and suitable for use. The coefficient of determination test assessed the combined contribution of the independent variables to the dependent variable. The G-test was used to determine the significance of the combined effect of the independent variables on the dependent variable. The Wald test identified which variables significantly influenced participation. The independent variables in this study included household income (Inc), education (Edu), knowledge (Know), participation in socialization (Soc), and family size (Fam). The logistic regression model used in this study is as follows:

$$g(x) = Ln\frac{P}{1-P} = \beta_0 + \beta_1 Inc + \beta_2 Edu + \beta_3 Know + \beta_4 Soc + \beta_5 Fam \quad [11] \quad (1)$$

Through logistic regression analysis, it is expected that the factors influencing community participation in waste bank programs can be identified. Once these factors are identified, participation can be increased to improve the productivity and effectiveness of waste bank implementation. Boosting participation in waste banks and waste processing will lead to a reduction in household waste generation, which will have a positive impact on the environment.

2.3.2 The Relation Between Participation and Circular Economy

A Causal-Loop Diagram (CLD) was used to analyze the relation between community participation and the implementation of a circular economy. CLDs consist of two main components: variables or factors, and arrows. Variables can represent actions, situations, or conditions that influence other variables [12]. According to Bala [13], the steps to construct a causal-loop diagram are: 1) defining the problem and goal, 2) identifying the most important elements or components, 3) identifying secondary and tertiary important elements, 4) determining cause-and-effect relationships, 5) identifying closed loops, and 6) identifying balancing and reinforcing relationships.

3 Result and Discussion

3.1 Respondents Characteristic

The majority of respondents were women and housewives. According to interviews, respondents stated that "wives" or "mothers" typically make decisions regarding waste management at home [14]. Most respondents had a family size of 4 members, with a total of 17 respondents or 34%. The number of family members influences the amount of waste generated daily. In addition to waste generation, family size also impacts household income. The average household income of respondents was IDR 4,825,200 per month, influenced by the type of occupation and the number of family members. Respondents' occupations included tailor, traders, teachers, and private employees. Those with relatively high incomes were typically respondents with stable jobs, such as teachers and employees, who also had other working family members.

Table 1. The Characteristic of Respondents

Variable	Frequency	Percentage (100%)
Sex		
Female	46	92
Male	4	8
Occupation		
Housewife	23	46
Private Employee	5	10
Entrepreneur	5	10
Seller	4	8
Tailor	4	8
Pensionary	4	8
Teacher	2	4
Civil Servant	1	2
Caregiver	1	2
Labor	1	2
Education (years)		
≤6	6	12
8	2	4
9	8	16
12	18	36
>12	16	32
Family Members		
1	3	6
2	8	16
3	15	30
4	17	34
≥6	7	14
Household Income		
800,000 – 3,549,999	24	48
3,550,000 – 6,299,999	12	24
6,300,000 – 9,049,999	8	16
9,050,000 – 11,799,999	4	8
≥11.800.000	2	4
Knowledge (Scoring)		
1	2	4
2	9	18
3	24	48
4	10	20
5	5	10
Socialization		
Joined	16	32
Not Joined	34	68
Participation		
Active	20	40
Passive	30	60

The research found that respondents demonstrated a high level of knowledge in waste classification and the economic value of waste. Out of the participants, 46 answered the waste classification question correctly, while 43 provided the right answer regarding the economic value of waste. Socialization varied across waste banks and were not regularly scheduled. Some respondents did not participate in socialization activities due to conflicting schedules, the distance to the socialization site, or lack of awareness about the event. Most respondents participated passively, engaging only in waste bank activities without participating in other waste processing activities.

3.2 Factors Affecting Community Participation in Waste Bank

3.2.1 Overall Model Fit

The overall model fit test showed a -2 Log Likelihood value of 67.301 at Step 0 and 37.005 at Step 1. The decrease in value was due to the inclusion of more variables. This reduction indicates that adding the five variables aligns well with the data being analyzed and observed.

3.2.2 Goodness of Fit Test

The goodness-of-fit test result was 0.711. This value exceeds the alpha value of 0.05, suggesting that the model aligns well with the study data [15].

3.2.3 Coefficient Determination Test (Nagelkerke R Square)

The Nagelkerke R-squared value was 0.614, which indicates that the independent variables in this study, including household income, education level, knowledge, participation in socialization, and family size, account for 61.4% of the variation in the dependent variable. The remaining 38.6% of the variation is affected by other variables not examined in this research.

3.2.4 Omnibus Test of Model Coefficient

The Omnibus Test of Model Coefficient result was 0.000. This result means that the independent variables (household income, education level, knowledge, participation in socialization, and family size) collectively affect the dependent variable of community participation.

3.2.5 Factors Affecting Community Participation in Waste Bank

The factors influencing community participation in the waste bank program are shown in Table 1 through the results of the Wald test.

Table 2. Factors Affecting Community Participation in Waste Bank

Variables	B	Exp(B)	Sig.
Income (Inc)	-8.0013E-8	1.000	0.506
Education (Edu)	0.119	1.126	0.488
Knowledge (Know)	1.040	2.829	0.036
Socialization (Soc)	2.376	1.766	0.016
Family Members (Fam)	0.487	1.628	0.206
Constant	-7.614	0.000	0.020

Based on Wald test results, the model of binary logistic regression used for this research is presented below.

$$g(x)= Ln\frac{P}{1-P} = -7.614 + -8.0013E\text{-}8Inc + 0.119Edu + 1.040Know + 2.376Soc + 0.487Fam \quad (2)$$

The Wald test results for the variable of household income showed a value of 0.506, indicating that the p-value is greater than $\alpha = 0.05$. This means that household income does not significantly affect the level of community participation, aligning with similar studies

conducted by Arifa et al. and Selomo et al. [10,16]. The odds ratio for household income is 1.000, suggesting that the possibility of participants becoming actively involved in the waste bank program with increased income is nearly 1.000 times, or very weak. The household income does not affect participation levels because of the motivation behind joining the waste bank program. Interviews with participants revealed that most respondents engage in the waste bank program primarily to clean their waste at home rather than for economic reasons. Additionally, their participation is also driven by a sense of environmental responsibility.

The Wald test results for education indicate that it does not have a significant impact on how actively people participate in the waste bank program, which is in line with previous studies by Arifa et al. and Yuliana and Wijayati [10,17]. The Wald test results for the education variable resulted a value of 0.488, indicating a p-value greater than $\alpha = 0.05$. Education also does not significantly affect the amount of waste generated by the community [18,19]. The odds ratio for the education variable is 1.126, meaning that the possibility of participants becoming actively involved in the waste bank program after receiving formal education is 1.126 times. This shows that awareness and knowledge about waste are not deeply taught to participants, making the length of education less impactful on participation. Instead, knowledge about waste is often provided through socialization and non-formal education conducted by local organizations and government.

On the other hand, the Wald test for the knowledge variable related to waste banks showed a value of 0.036, meaning the p-value is less than $\alpha = 0.05$. This indicates that knowledge significantly affect community participation levels. This finding aligns with research by Arifa et al., Yuliana and Wijayanti, and Rama and Purnama [10,17,20]. The odds ratio for the knowledge variable is 2.829, meaning that participants are 2.829 times more likely to participate actively in the waste bank program with increased knowledge. The higher a person's understanding of waste, the greater their awareness of the issues surrounding it [21]. Based on the questionnaires distributed, the community already understands waste classification by source, making it easier for them to sort and deposit waste at the waste bank each month. Education about waste banks and how they operate also facilitates active community participation. Knowledge also empowers people to realize that even their smallest contributions can have a significant positive impact on the environment.

The Wald test results for socialization also indicate that this variable is significant, which showed a value of 0.016, indicating a p-value less than $\alpha = 0.05$. This demonstrates that socialization has a significant impact on community participation levels. This finding is in line with research by Saputra et al. [22], which explains that individuals who have attended socialization sessions are more likely to show interest in participating in waste bank activities. The odds ratio for the socialization variable is 10.766, indicating that participants who have been involved in socialization are 10.766 times more likely to participate actively in the waste bank program. Socialization efforts by local officials and organizations help increase knowledge about waste management issues. As knowledge grows, so does awareness about waste. Additionally, waste bank socialization events are often equipped with adequate facilities, further boosting community participation in the program.

Lastly, the Wald test results for the number of family members reveal that this factor has little effect on how actively people participate in the waste bank program. The Wald test for the variable of the number of family members showed a value of 0.206, indicating a p-value greater than $\alpha = 0.05$. Therefore, the number of family members does not significantly affect community participation levels, as also stated in the research by Selomo et al. [16]. The odds ratio for the number of family members is 1.628, meaning that the possibility of participants being actively involved in the waste bank program with more family members is 1.628 times. Interviews with respondents revealed that, in most families, only one member participates in waste bank activities. The interviews also shows that not all family members live in the same house. For instance, some respondents have children who work or study outside the home.

The amount of waste generated by a family is influenced by the number of people living in the household. If not all family members reside in the same house, the amount of waste produced is also reduced.

3.3 The Relation Between Participation and Circular Economy

This research will form a causal diagram model between the variables of socialization, knowledge level, community participation, waste management and utilization, and the circular economy. The diagram is as follows:

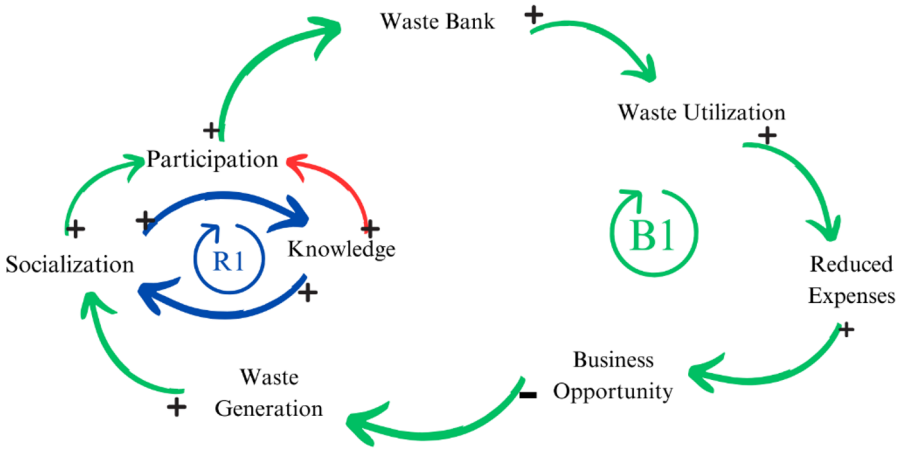

Figure 1. Causal Loop Diagram Model by author.

The relationship between socialization, knowledge, and participation is depicted in CLD R1. The variables of socialization and knowledge have a reinforcing relationship with the participation variable, indicated by a "+" sign [23,24]. Based on the results of the logistic regression analysis, socialization and knowledge have a significant impact on community participation in the waste bank program. If there is an increase in socialization and knowledge, participation levels will also increase. Socialization activities will enhance knowledge about waste [25]. On the other hand, the implementation of socialization also requires sufficient knowledge about the socialization materials to be provided. Adequate knowledge will make it easier for the community to conduct socialization to others [26]. This was demonstrated in the socialization of maggot utilization held at Kopen Sae Waste Bank. The speaker in this socialization was an informant with sufficient knowledge about maggots. Socialization conducted without adequate knowledge can risk causing harm to the participants. Therefore, these two variables are depicted as having a reinforcing loop relationship.

CLD B1 shows a balancing loop relationship [23], representing the balance between waste generation, socialization, participation, waste bank activities, expenses, and business opportunities. High waste generation leads to environmental problems such as water, air, and soil pollutions, as well as the spread of diseases. Therefore, socialization activities are organized to encourage community cooperation with the government in reducing waste generation in residential areas [27]. Socialization conducted by organizations or officials will help the community to learn and increase their knowledge about waste management and waste banks. The socialization implementation is also expected to continuously support the community in developing the habit of managing waste. Enhanced knowledge will boost

community participation in the waste bank program. With increased participation, the amount of processed waste will also increase, leading to increased results.

Proper waste management and processing will reduce community expenses and the amount of waste generated in Sukoharjo Regency. The waste bank programs in Sukoharjo Regency consist of two main activities: waste management and waste utilization. Waste management activities include sorting waste by type, such as plastic, cardboard, iron, and paper. The waste will be sold, and the proceeds from the sale will be deposited into the customer's account. Customers can withdraw these funds during holidays or at the end of the year. Other waste management activities are carried out at Maju Lancar Bodeyan Waste Bank, where customers have been provided with the knowledge to use composters for separating organic and inorganic waste. Waste utilization by the waste bank includes the use of maggots, production of eco-enzyme, and creation of garden dividers using bottles, old cloth, or unused roof tiles.

Figure 2. The utilization of bottles, used cloth, and unused roof tiles

The waste bank program is one of the implementations of a circular economy [28,29]. Waste utilization, which produces products like eco-enzyme, will reduce community expenses on purchasing cleaning products. Redirecting or saving these expenses for other purposes will also decrease single-use packaging waste. The same applies to creating garden dividers using plastic bottles and old cloth, where the community does not need additional costs for farming.

Figure 3. Eco-Enzym Soap produced by Bunga Raya Waste Bank

In addition to reducing expenses, waste utilization can also become a business opportunity to improve the economy [30]. Waste banks provide facilities for the community to sell sorted waste without needing to process it further. Unprocessed inorganic waste can be sold at varying prices, depending on the type of waste collected. The business opportunities in waste management and processing activities are expected to reduce the

amount of waste generated by turning waste into raw materials for product creation or selling it back to manufacturers of recycled goods through waste collectors.

The widespread implementation of waste banks, not limited to a single area, will increase waste processing and reduction. This reduction will mitigate various environmental problems, such as disease and pollution. Additionally, waste can be processed into more varied products, not only household items but also energy with advanced waste processing technology, such as electricity and biogas. These sources of problems can become economic resources if effectively utilized and supported by community and government participation.

4 Conclusion

The issue of waste is a problem that society must continually address. One solution to this problem is implementing a circular economy system that processes waste into reusable items. Implementing a circular economy requires community participation in sorting, collecting waste, and participating in waste processing activities at waste banks. Community participation can be increased by enhancing knowledge related to waste through appropriate and continuous socialization. The effectiveness of implementing a circular economy through waste banks can also be enhanced by integrating them with other sectors like livestock and agriculture. Livestock waste, such as cow manure, can be processed into biogas, which is useful for daily activities. The implementation of integrated waste banks requires further research, as well as cooperation and collaboration between researchers, local communities, the government, and stakeholders. Therefore, awareness and cooperation from all parties are needed regarding waste issues to reduce the harmful impacts of waste.

References

1. E. Purwanto and M. R. Hakim, *Pengelolaan Bank Sampah* (Penerbit NEM, 2021).
2. H. Inayah and A. Istiqomah, J. Ilmu Pertan. Indones. **26**(1), 159–166 (2021).
3. P. A. Shentika, JESP **8**(1), 92–100 (2016).
4. J. Kirchherr, D. Reike, and M. Hekkert, Resour. Conserv. Recycl. **127**, 221–232 (2017).
5. S. Ojha, S. Bußler, and O. K. Schlüter, Waste Manag. **118**, 600–609 (2020).
6. B. Darmawan, M. Mulyanto, and D. Tahyudin, J. Empirika **4**(1), 33–48 (2019).
7. A. D. Sapitri, E. Priyanti, and D. Kurniansyah, Community Dev. J. J. Pengabdi. Masy. **4**(2), 4005–4011 (2023).
8. T. Purwanti, Prof. J. Komun. dan Adm. Publik **9**(2), 623–632 (2022).
9. J. F. Hair, B. J. Babin, W. C. Black, and R. E. Anderson, *Multivariate Data Analysis* (Cengage, 2019).
10. F. Arifa, F. P. Cita, and A. H. Ilman, Nusant. J. Econ. **1**(01), 14–27 (2019).
11. D. W. Hosmer, S. Lemeshow, and R. X. Sturdivant, *Applied Logistic Regression: Chapter 4* (2013), **95**(44).
12. A. H. Kristianto and J. P. Nadapdap, Sebatik **25**(1), 59–67 (2021).
13. B. K. Bala, *Energy Systems Modeling and Policy Analysis* (CRC Press, 2022).
14. B. Burhanuddin, H. Harjito, M. T. Pathiassana, and R. T. Pathiussina, J. Tambora **5**(2), 87–96 (2021).
15. E. Roflin, F. Riana, E. Munarsih, and I. A. Liberty, *Regresi Logistik Biner Dan Multinomial* (Penerbit NEM, 2023).
16. M. Selomo, A. B. Birawida, A. Mallongi, and M. Muammar, Media Kesehat. Masy. Indones. **12**(4), 232–240 (2016).
17. I. Yuliana and Y. Wijayanti, HIGEIA (Journal of Public Health Research and

Development), 3 (4), 545–555, (2019).
18. Y. Setiawan, S. Nugroho, and A. D. C. D. Saputri, J. Teknol. Lingkung. **6**(1), 53–57 (2022).
19. Y. Setiawan, M. Busyairi, and P. Faradillah, J. Teknol. Lingkung. UNMUL **6**(2), 11–17 (2022).
20. G. A. Rama and S. G. Purnama, Arch. Community Heal. **4**(1), 1 (2019).
21. M. J. Saptenno, L. B. Saptenno, and N. R. Timisela, J. Ilmu Lingkung. **20**(2), 365–374 (2022).
22. A. B. P. Saputra, C. Meidiana, and E. S. Kartika, Plan. Urban Reg. Environ. **12**(1), 261–268 (2023).
23. V. R. Coletta, A. Pagano, I. Pluchinotta, U. Fratino, A. Scrieciu, F. Nanu, and R. Giordano, J. Environ. Manage. **280**, 111668 (2021).
24. A. Latif, *Strategi Keberlanjutan Pengelolaan Limbah Ternak Berbasis Circular Economy di Gapoktan Taruna Mukti, Kabupaten Bandung*, in Proceedings of National Conference West Java Economic Society, WJES, Indonesia (2022)
25. J. W. Tuahatu, G. D. Manuputty, and N. C. Tuhumury, HIRONO J. Pengabdi. Masy. **2**(1), 44–54 (2022).
26. A. Ishak, S. Budiyono, F. Emlan, F. Jhon, and K. Harwi, AgriHumanis J. Agric. Hum. Resour. Dev. Stud. **3**(1), 1–12 (2022).
27. B. Mulyati, Y. F. Ilmi, and A. Basri, Bantenese J. Pengabdi. Masy. **5**(1), 26–34 (2023).
28. A. B. Dharma, D. Susanti, and P. Marlinda, Sebatik **27**(1), 145–154 (2023).
29. F. C. Mihai, S. Gündogdu, L. A. Markley, A. Olivelli, F. R. Khan, C. Gwinnett, J. Gutberlet, N. Reyna-Bensusan, P. Llanquileo-Melgarejo, C. Meidiana, S. Elagroudy, V. Ishchenko, S. Penney, Z. Lenkiewicz, and M. Molinos-Senante, Sustain. **14**(1), (2022).
30. V. Bozhanova, P. Korenyuk, O. Lozovskyi, S. Belous-Sergeeva, O. Bielienkova, and V. Koval, Int. J. Math. Eng. Manag. Sci. **7**(3), 350–363 (2022).