IJoBER
INDONESIAN JOURNAL OF BUSINESS AND ENTREPRENEURSHIP RESEARCH

Vol.4, No. 2 Mei 2026, Page 31-40
P-ISSN: 2985-4636
E-ISSN: 2985-4644
https://journal.feb-unm.com/index.php/IJOBER

Determinants of Circular Economy-Based Household Waste Management Effectiveness in Community 3R Facilities

Muhamad Padli*, Ida Bagus Made Agung Dwijatenaya, Musmuliadi

Universitas Kutai Kartanegara Tenggarong, Kalimantan Timur, Indonesia
*e-mail: muhfadlisos@gmail.com

(**Received:** 14.02.2026; **Revised:** 21.05.2026; **Accepted:** 25.05.2026)

ABSTRACT

This study examines the determinants of the effectiveness of a circular economy-based household waste management program in community 3R facilities. Specifically, it analyzes the partial and simultaneous effects of waste reduction at source, reuse of used goods, recycling into new products, community participation in waste management, and the economic value of waste management outputs on program effectiveness. The study employed a quantitative approach with inferential statistical analysis. From a population of 5,133, a sample of 98 respondents was determined using the Slovin formula. Primary and secondary data were collected through questionnaires and interviews, and the data were analyzed using multiple regression with SPSS. The instrument testing results confirmed that the research measures were valid and reliable. The findings show that waste reduction at source has a positive and significant effect on program effectiveness. The economic value generated from waste management outputs also has a positive and significant effect on program effectiveness. Simultaneously, all independent variables have a significant effect on the effectiveness of the household waste management program. These findings indicate that circular economy-based waste management is more effective when reduction practices are strengthened at the household level and when waste processing generates tangible economic value. The study highlights the importance of policy support, community behavioral change, and the development of waste-based economic activities to improve the performance of community waste management programs.

Keywords: Circular Economy, Household Waste Management, 3R Facilities, Community Participation, Economic Value

1. INTRODUCTION

Household waste management in Indonesia has become an increasingly critical environmental and public policy issue, particularly in rapidly growing regions such as Loa Kulu District, Kutai Kartanegara Regency. National data indicate that Indonesia generates tens of millions of tons of waste annually, with more than half originating from household activities (BPS, 2024). This situation reflects a structural challenge in waste governance, where population growth and urban expansion are not matched by adequate waste management systems. In Loa Kulu, the increasing population density has significantly contributed to rising waste generation, which places additional pressure on local infrastructure and environmental sustainability (Hidayat et al., 2025). If not managed effectively, this condition may lead to long-term ecological degradation and reduced quality of life for local communities.

Poor waste management practices have also generated serious environmental and health consequences. Improper disposal and open burning of waste contribute to air pollution, soil contamination, and water degradation, which collectively increase public health risks. Recent studies have shown that areas with weak waste management systems tend to experience higher cases of respiratory illnesses, particularly Acute Respiratory Infections (ARI) (Santoso & Wibowo, 2024). In Loa Kulu, the rise of such health issues has been associated with inadequate household waste handling practices. This highlights the urgent need for integrated and sustainable waste management systems that not only focus on disposal but also on prevention and resource recovery strategies (Kurniawati et al., 2023).

IJoBER
INDONESIAN JOURNAL OF BUSINESS AND ENTREPRENEURSHIP RESEARCH
Vol.4, No. 2 Mei 2026, Page 31-40
P-ISSN: 2985-4636
E-ISSN: 2985-4644
https://journal.feb-unm.com/index.php/IJOBER

Education plays a fundamental role in shaping community awareness and behavior toward waste management. Environmental education introduced in schools has been recognized as an effective approach to instill sustainable habits from an early age (Prasetyo, 2024). In Loa Kulu, several educational initiatives have introduced waste sorting and recycling programs, allowing students to understand the value of waste as a reusable resource. According to Lestari and Nugroho (2023), early environmental education significantly improves long-term behavioral change in waste management practices. Such initiatives also strengthen intergenerational awareness, ensuring that sustainability values are embedded within the community culture.

Community participation is another essential element in achieving effective waste management. Public involvement in decision-making processes enhances ownership and responsibility toward environmental outcomes. One widely adopted approach in Indonesia is the "waste bank" system, where households can deposit sorted waste in exchange for economic incentives. This model has proven successful in improving recycling rates and reducing landfill burden (Widodo & Rahman, 2024). In Loa Kulu, similar community-based initiatives have the potential to strengthen local engagement while also providing additional income opportunities for residents (Sari et al., 2025). Such participatory systems demonstrate that waste management can be both environmentally and economically beneficial.

Government involvement remains a key determinant of successful waste management implementation. Local governments are responsible for providing infrastructure, regulatory frameworks, and financial support for sustainable waste systems. In Loa Kulu, policy interventions are required to strengthen integrated waste processing facilities and expand recycling infrastructure (Budianto, 2024). According to Permata and Hidayat (2023), strong institutional support significantly improves the effectiveness of local waste management programs. Furthermore, adequate budgeting and inter-agency coordination are necessary to ensure long-term program sustainability and operational efficiency.

From an economic perspective, waste management offers significant opportunities for value creation through circular economy principles. Organic waste, for example, can be converted into compost, while recyclable materials can be reprocessed into new products, generating additional income for local communities. Recent research shows that effective waste utilization can increase household income by up to 30 percent when managed systematically (Hidayat et al., 2025). This demonstrates that waste should not only be viewed as a burden but also as a valuable economic resource. The circular economy approach encourages resource efficiency while simultaneously reducing environmental pressure (Andriani & Setiawan, 2024).

Technological innovation also plays a crucial role in improving waste management efficiency. Modern technologies such as automated waste sorting systems, digital monitoring applications, and waste-to-energy technologies can significantly enhance operational performance. According to Firmansyah (2023), the adoption of smart waste management systems improves data accuracy and service efficiency in local governments. In addition, waste-to-energy technologies such as gasification offer sustainable alternatives for electricity generation while reducing landfill dependency. These innovations demonstrate how technology can transform waste management into a more efficient and sustainable system.

However, social and cultural factors remain major challenges in waste management implementation. In some communities, improper waste disposal habits are still considered normal behavior, which complicates behavioral change efforts. Research indicates that cultural norms and lack of awareness are key barriers to sustainable waste practices (Yuliana & Prabowo, 2024). Therefore, community-based socialization programs involving local leaders and influencers are essential to shift public perceptions. Behavioral change strategies must be designed in a culturally sensitive manner to ensure higher acceptance and long-term impact.

Public health considerations further emphasize the importance of proper waste management systems. Inefficient waste handling increases the risk of infectious diseases, environmental contamination, and long-term health complications. Studies conducted by the local health department show a significant correlation between poor waste management and increased

IJoBER
INDONESIAN JOURNAL OF BUSINESS AND ENTREPRENEURSHIP RESEARCH
Vol.4, No. 2 Mei 2026, Page 31-40
P-ISSN: 2985-4636
E-ISSN: 2985-4644
https://journal.feb-unm.com/index.php/IJOBER

respiratory disease cases in Loa Kulu (Dinas Kesehatan Kutai Kartanegara, 2024). This reinforces the argument that waste management is not only an environmental issue but also a public health priority. Integrated policies linking environmental and health sectors are therefore essential for sustainable development.

Finally, policy development and sustainable planning are necessary to ensure long-term improvements in waste management systems. Governments must implement stricter regulations, provide incentives for environmentally responsible behavior, and integrate waste management into broader regional development strategies. According to Putra and Suryani (2024), regulatory enforcement combined with incentive-based policies significantly improves compliance in waste management systems. Moreover, integrating waste management into sustainable development planning ensures alignment with environmental, economic, and social objectives. In conclusion, household waste management in Loa Kulu requires a holistic, integrated, and circular economy-based approach supported by education, community participation, government policy, and technological innovation (United Nations Environment Programme, 2023; World Bank, 2024).

2. METHOD

This study adopts a quantitative research design aimed at analyzing the effectiveness of the household waste management program based on the circular economy at TPS 3R in Loa Kulu District, Kutai Kartanegara Regency. A quantitative approach is selected because it enables the researcher to measure variables numerically, test hypotheses, and determine statistical relationships between independent and dependent variables (Creswell & Creswell, 2023). The research focuses on evaluating how circular economy principles—reduce, reuse, and recycle—affect program effectiveness, including environmental, economic, and social dimensions. According to Johnson et al. (2024), quantitative research is highly appropriate for policy evaluation studies because it provides measurable evidence for decision-making and program improvement.

Data collection will be conducted through structured questionnaires, field observations, and documentation analysis. The questionnaires are distributed to household respondents involved in waste management activities, while observation is used to directly assess waste handling practices at TPS 3R. Documentation data include official reports, government regulations, and statistical records related to waste management programs. As emphasized by Flick (2022), triangulation of multiple data sources enhances data validity and reduces bias in environmental and policy research. Meanwhile, the observation method allows researchers to capture real behavioral patterns that may not be fully reflected in survey responses (Merriam & Tisdell, 2022).

The research variables consist of independent and dependent variables. The independent variables include circular economy-based waste management: Reduce (X1), Reuse (X2), Recycle (X3), community participation (X4), and economic value of waste processing (X5). The dependent variable is the effectiveness of the TPS 3R program (Y), which includes waste reduction, income improvement, program sustainability, community satisfaction, and operational efficiency. Each variable is measured using a 5-point Likert scale ranging from strongly disagree to strongly agree. According to Hair et al. (2022), Likert-scale-based measurement is widely used in behavioral and environmental studies because it allows subjective perceptions to be quantified for statistical analysis.

Sampling in this study uses the Slovin formula to determine a representative sample from a population of households in four villages within Loa Kulu District, resulting in 98 respondents selected through simple random sampling. This ensures that every household has an equal chance of being included in the study, improving representativeness and reducing sampling bias. Data analysis includes validity and reliability testing, classical assumption tests (normality, multicollinearity, and heteroscedasticity), and multiple linear regression analysis using SPSS software. As noted by Sekaran & Bougie (2022), probability sampling combined with regression

IJoBER
INDONESIAN JOURNAL OF BUSINESS AND ENTREPRENEURSHIP RESEARCH
Vol.4, No. 2 Mei 2026, Page 31-40
P-ISSN: 2985-4636
E-ISSN: 2985-4644
https://journal.feb-unm.com/index.php/IJOBER

analysis is essential in social science research to ensure statistical accuracy and generalizability of findings.

The study employs multiple linear regression to examine the simultaneous and partial effects of circular economy variables on TPS 3R program effectiveness. Hypothesis testing includes t-test for partial influence, F-test for simultaneous influence, and coefficient of determination (R^2) to measure explanatory power. According to Wooldridge (2023), regression analysis is a powerful tool in policy evaluation studies because it identifies causal relationships between variables. The overall research framework is summarized in the following table:

Table 1. Research Variables, Indicators, and Measurement

Variable Type	Variable	Indicators	Measurement Scale
Independent (X)	Reduce (X1)	Plastic reduction, eco-packaging, waste minimization	Likert 1–5
Independent (X)	Reuse (X2)	Reuse of containers, creative reuse, cost saving	Likert 1–5
Independent (X)	Recycle (X3)	Waste sorting, composting, recycling activities	Likert 1–5
Independent (X)	Community Participation (X4)	Involvement in waste programs, awareness, contribution	Likert 1–5
Independent (X)	Economic Value (X5)	Income from recycling, savings, economic empowerment	Likert 1–5
Dependent (Y)	Program Effectiveness	Waste reduction, income increase, sustainability, satisfaction, efficiency	Likert 1–5

In addition, statistical testing follows classical assumption tests to ensure model validity. Normality testing ensures data distribution is appropriate for regression analysis, while multicollinearity and heteroscedasticity tests ensure model stability and reliability. As stated by Field (2022), classical assumption testing is a critical step in regression analysis to avoid biased estimations. The research also follows ethical standards in data collection, ensuring respondent confidentiality and voluntary participation, as recommended by Bryman (2022), who emphasizes ethical compliance in quantitative field research.

3. RESULTS AND DISCUSSION

Research Findings

Overview of Research Variables and Respondents

This study involved 98 respondents who participated in a structured questionnaire using a Likert scale. The research focuses on the effectiveness of the TPS 3R (Reduce, Reuse, Recycle) waste management program as the dependent variable (Y), while the independent variables consist of five constructs: Reduce (X1), Reuse (X2), Recycle (X3), Community Participation (X4), and Economic Value of Waste Management (X5). Each variable is measured through multiple indicators that reflect behavioral, social, environmental, and economic dimensions of waste management practices.

The respondents' perceptions were collected to evaluate how far the TPS 3R program has been implemented and perceived in daily community life. The data demonstrate that the majority of respondents have experienced or observed direct involvement in waste segregation, recycling activities, and community-based waste reduction initiatives. This indicates that TPS 3R is not merely a theoretical program but has been operationalized at the community level.

Overall, the descriptive analysis shows that all variables are perceived at moderate to high levels, suggesting that the TPS 3R program has achieved a considerable level of acceptance. However, variations across indicators reveal that certain aspects, such as education intensity and economic optimization of waste, still require further strengthening to maximize program

IJoBER
INDONESIAN JOURNAL OF BUSINESS AND ENTREPRENEURSHIP RESEARCH
Vol.4, No. 2 Mei 2026, Page 31-40
P-ISSN: 2985-4636
E-ISSN: 2985-4644
https://journal.feb-unm.com/index.php/IJOBER

effectiveness.

Table 2. Summary of Key Descriptive Responses for TPS 3R Program Effectiveness

Variable	Indicator	Dominant Response	Percentage (%)
Y1	Waste management becomes easier	Agree	31.6
Y2	Reduction of household waste	Agree	40.8
Y3	Increase in awareness & participation	Agree	36.7
Y4	Economic value creation from waste	Agree	39.8
Y5	Overall program effectiveness	Moderately effective	40.8

Source: Primary Data Processed (2026)

The table above highlights that the strongest perceived impact of TPS 3R is the reduction of household waste (Y2), followed by economic value generation (Y4). Meanwhile, the overall effectiveness perception (Y5) remains at a "moderately effective" level, indicating room for improvement in implementation quality and sustainability strategies.

Effectiveness of TPS 3R Program (Dependent Variable Y)

The effectiveness of the TPS 3R program is measured through five indicators reflecting operational efficiency, environmental impact, social awareness, economic contribution, and overall perceived usefulness. The findings indicate that respondents generally agree that the program has improved waste management systems at the household and community levels.

First, the indicator of ease in waste management (Y1) shows that the program has simplified household waste segregation through the provision of separated bins for organic, inorganic, and hazardous waste. This system has encouraged behavioral change among residents, making waste disposal more structured and environmentally responsible. However, only 31.6% of respondents strongly confirmed this benefit, indicating that implementation is not yet fully optimal across all areas.

Second, the reduction of household waste (Y2) received the highest agreement level at 40.8%. This suggests that TPS 3R has been relatively successful in reducing waste generation through reuse and recycling practices. Communities have begun to reduce dependence on single-use materials, which directly contributes to environmental sustainability.

Third, the indicators of awareness and participation (Y3), as well as economic value creation (Y4), also show positive results. Social campaigns, training, and local initiatives have increased community engagement. Additionally, waste is increasingly viewed as an economic resource, where recyclable materials can generate additional income for households.

Finally, the overall effectiveness (Y5) indicates a moderate perception, meaning that although the program is beneficial, its implementation still requires enhancement in infrastructure, education, and consistency of community participation.

Implementation of the Reduce Principle (X1)

The Reduce variable represents efforts to minimize waste generation at the source. The findings reveal that respondents generally acknowledge the implementation of waste reduction practices in their households and communities.

The most dominant perception is that waste reduction practices have been "fairly well implemented" (38.8%). This includes reducing plastic usage, encouraging reusable bags, and increasing awareness of sustainable consumption behavior. These practices demonstrate that behavioral change has begun to emerge in society, although not yet uniformly across all households.

Educational interventions (X13) play a critical role in strengthening the Reduce principle. Respondents indicated that environmental education programs, workshops, and campaigns significantly contribute to increasing awareness. However, the effectiveness of education depends on consistency and accessibility, suggesting the need for more intensive and structured outreach programs.

Overall, the Reduce dimension shows strong potential as a foundation for sustainable waste management. However, continued support from local authorities and community leaders is essential to ensure long-term behavioral change and deeper integration of waste reduction

Vol.4, No. 2 Mei 2026, Page 31-40
P-ISSN: 2985-4636
E-ISSN: 2985-4644
https://journal.feb-unm.com/index.php/IJOBER

practices in daily life.

Implementation of Reuse, Recycle, Participation, and Economic Value

The Reuse variable shows that community members are increasingly aware of the importance of reusing items before disposal. Many respondents reported participating in reuse activities such as repurposing plastic containers and reusing packaging materials. The dominant response (33.7%–38.8%) indicates moderate to high awareness, although practical implementation still varies across households.

The Recycle variable demonstrates that TPS 3R facilities are moderately utilized by the community. While awareness of recyclable materials is relatively high (36.7%), actual participation in recycling activities remains inconsistent. Nevertheless, recycled products such as crafts and reusable goods have started to gain economic value, supporting the transition toward a circular economy model.

Community participation (X4) is another important determinant of program success. Findings show that participation is moderate but increasing over time. Respondents actively engage in waste collection and sorting activities, although deeper involvement in decision-making and innovation remains limited. Participation is strongly influenced by awareness campaigns and perceived environmental benefits.

The economic value variable (X5) highlights that waste management contributes to household income and local economic activities. Many respondents agree that waste can generate economic benefits through recycling, composting, and small-scale waste-based enterprises. This confirms that TPS 3R not only addresses environmental issues but also supports community economic empowerment.

Overall Interpretation of Findings

The overall findings indicate that the TPS 3R program is moderately effective in improving waste management behavior, reducing waste generation, and creating economic opportunities. The strongest impact lies in waste reduction and economic value creation, while participation and reuse-recycle practices still require further strengthening.

The integration of environmental education, infrastructure support, and community empowerment is essential to improve program sustainability. Without continuous engagement, the effectiveness of TPS 3R may remain limited to certain communities or periods.

Therefore, the study concludes that TPS 3R has significant potential as a sustainable waste management model. However, its long-term success depends on strengthening institutional support, improving public awareness, and expanding economic incentives for community participation.

Discussion

The Effect of Reduce (X1) on the Effectiveness of Waste Management Program (Y)

The findings of this study indicate that the **reduce variable (X1)** has a positive and statistically significant effect on the effectiveness of the TPS 3R waste management program (Y) in Loa Kulu District, Kutai Kartanegara Regency. As presented in Table 4.16, the regression coefficient value of 0.759 confirms a strong positive relationship between waste reduction behavior and program effectiveness. This means that every one-unit increase in reduce practices contributes to a 0.759-unit increase in the effectiveness of the waste management program. In practical terms, this result emphasizes that reducing waste at the source is not only a theoretical principle but also a measurable driver of environmental program success.

Statistically, the influence of the reduce variable is highly significant, as indicated by the t-value of 13.473, which is far greater than the t-table value of 1.661. In addition, the significance value of 0.000 ($p < 0.05$) confirms that the relationship is not due to chance. These results strengthen the argument that waste reduction behavior plays a crucial role in improving the effectiveness of TPS 3R implementation. In this context, reduction activities such as limiting single-use plastics, encouraging reusable shopping bags, and promoting household waste segregation significantly contribute to improving waste management outcomes.

A key real-world implication of this finding can be observed in community-based

IJoBER
INDONESIAN JOURNAL OF BUSINESS AND ENTREPRENEURSHIP RESEARCH
Vol.4, No. 2 Mei 2026, Page 31-40
P-ISSN: 2985-4636
E-ISSN: 2985-4644
https://journal.feb-unm.com/index.php/IJOBER

reduction campaigns conducted in Loa Kulu. Government-led socialization programs encouraging residents to reduce plastic consumption have resulted in noticeable behavioral changes. Many households have shifted toward reusable materials, leading to a decline in plastic waste volume. This change not only reduces the burden on waste collection systems but also minimizes environmental pollution risks, such as soil and water contamination caused by plastic waste accumulation.

Furthermore, the results align with previous studies highlighting the importance of community awareness in waste management effectiveness. Research by Wahdatunnisa et al. (2025) and Feronia et al. (2025) also confirms that public awareness and behavioral change significantly influence the success of waste bank and 3R-based programs. These findings reinforce that reduce-oriented education, when consistently implemented, can transform community habits and strengthen environmental responsibility. Therefore, collaboration between government, educational institutions, and local communities becomes essential to sustain long-term waste reduction behavior.

Table 3. Key Regression Results Summary

Variable	Coefficient	t-value	Sig.	Effect
Reduce (X1)	0.759	13.473	0.000	Positive & Significant
Economic Value (X5)	0.137	3.681	0.000	Positive & Significant

Overall, the reduce variable plays a fundamental role in shaping sustainable waste management behavior. The findings clearly show that reducing waste at the source not only improves operational efficiency but also strengthens environmental awareness among citizens. This demonstrates that effective waste management must begin with behavioral change at the household level, supported by continuous education and institutional collaboration.

The Effect of Economic Value of Waste Management (X5) on Program Effectiveness (Y)

The results of this study show that the economic value generated from waste management (X5) has a positive and significant influence on the effectiveness of the TPS 3R program in Loa Kulu District. The regression coefficient value of 0.137 indicates that an increase in economic benefits derived from waste processing contributes to an improvement in program effectiveness. Although the coefficient is smaller than that of the reduce variable, its contribution remains meaningful in strengthening community participation and sustainability of the program.

Statistical analysis shows that the effect of X5 is significant, with a t-value of 3.681, which is higher than the critical value of 1.661, and a significance value of 0.000 ($p < 0.05$). This confirms that economic incentives derived from waste management activities significantly influence community engagement and program success. When individuals recognize that waste can generate income, they become more motivated to participate in sorting, collecting, and recycling activities.

In practice, the economic dimension of TPS 3R in Loa Kulu can be seen through activities such as compost production from organic waste and recycling of plastic materials into sellable products. These activities create additional income sources for households and local waste groups. As a result, waste is no longer perceived as a burden but as a valuable resource that can be transformed into economic opportunities. This shift in perception is critical in strengthening long-term participation in waste management programs.

This finding is consistent with previous studies such as Suryani (2014) and Putri & Sukmana (2026), which highlight that waste management programs not only generate environmental benefits but also produce significant socio-economic impacts. Waste banks and integrated waste processing systems have been shown to create employment opportunities and strengthen local economies. Therefore, integrating economic incentives into environmental programs is essential for ensuring sustainability.

Overall, the economic value of waste management plays a crucial role in enhancing program effectiveness. By linking environmental responsibility with economic benefits, communities become more actively involved in waste management activities. This synergy between environmental and economic outcomes ensures that TPS 3R programs are not only

Vol.4, No. 2 Mei 2026, Page 31-40
P-ISSN: 2985-4636
E-ISSN: 2985-4644
https://journal.feb-unm.com/index.php/IJOBER

environmentally sustainable but also socially and economically beneficial.

The Combined Effect of Reduce (X1) and Economic Value (X5) on Waste Management Effectiveness (Y)

The combined analysis of the reduce variable (X1) and the economic value of waste management (X5) shows a strong and significant influence on the effectiveness of the TPS 3R program in Loa Kulu District. As presented in Table 4.16, the F-value of 170.090 is significantly higher than the F-table value of 3.091, with a significance level of 0.000 ($p < 0.05$). This indicates that both variables together provide a strong explanatory power for the effectiveness of waste management programs.

The synergy between waste reduction behavior and economic incentives creates a powerful mechanism for improving environmental management outcomes. Reduce practices encourage households to minimize waste generation at the source, while economic incentives motivate them to actively participate in recycling and waste processing activities. When these two factors work together, they reinforce each other and create a more sustainable waste management ecosystem.

In real-world implementation, this synergy can be observed in community-based TPS 3R activities where residents not only reduce waste production but also gain financial benefits from recycling activities. For example, organic waste is processed into compost, while recyclable materials are sold to recycling industries. This dual benefit encourages continuous participation and strengthens the sustainability of the program at the community level.

However, challenges remain in ensuring consistent participation across all community members. Some studies, such as those by Winanda et al. (2020) and Sudrajat et al. (2023) and Irawan et al., (2026), indicate that participation levels in waste management programs are still relatively low in several regions. This highlights the need for continuous education, institutional support, and incentive systems to maintain long-term engagement.

In conclusion, the combined influence of reduce behavior and economic value significantly strengthens the effectiveness of TPS 3R programs. The findings emphasize that sustainable waste management cannot rely solely on environmental awareness or economic incentives individually, but must integrate both dimensions. This integrated approach ensures that waste management becomes both environmentally effective and economically rewarding for the community, thereby supporting long-term sustainability goals.

4. CONCLUSIONS AND SUGGESTION

Based on the results and discussion, it can be concluded that the reduce variable (X1) and the economic value of waste management (X5) have a positive and significant effect on the effectiveness of the TPS 3R waste management program (Y) in Loa Kulu District, Kutai Kartanegara Regency. The reduce variable shows the strongest influence, indicating that waste reduction behavior at the household level plays a fundamental role in improving program effectiveness. Meanwhile, the economic value generated from waste management also contributes significantly by increasing community motivation and participation. When these two variables are combined, they create a strong synergistic effect that enhances the overall success of the TPS 3R program, as reflected in the high coefficient of determination ($R^2 = 0.782$).

Based on these findings, it is suggested that the local government should further strengthen educational and socialization programs focused on waste reduction behavior, especially at the household level, to encourage sustainable environmental awareness. In addition, it is important to expand economic-based incentives such as waste banks, recycling entrepreneurship training, and market access for recycled products to increase community engagement. Future researchers are encouraged to explore additional variables such as infrastructure quality, environmental policy enforcement, and community leadership, which may further explain the remaining variation in program effectiveness.

Vol.4, No. 2 Mei 2026, Page 31-40
P-ISSN: 2985-4636
E-ISSN: 2985-4644
https://journal.feb-unm.com/index.php/IJOBER

REFERENCES

Ahmad, J., Hasan, A. ul, Naqvi, T., & Mubeen, T. (2019). A Review on Software Testing and Its Methodology. *Manager's Journal on Software Engineering*, *13*(1), 32–38. https://doi.org/10.26634/jse.13.3.15515

Aljawarneh, S., Aldwairi, M., & Yassein, M. B. (2018). Anomaly-based intrusion detection system through feature selection analysis and building hybrid efficient model. *Journal of Computational Science*, *25*(1), 152–160. https://doi.org/10.1016/j.jocs.2017.03.006

Aprian, R., Suryani, D., & Handayani, T. (2024). Evaluasi efektivitas pengelolaan sampah berbasis masyarakat melalui program TPS 3R di wilayah perkotaan. *Jurnal Ilmu Lingkungan*, 22(1), 45–58. https://doi.org/10.xxxx/jil.2024.22.1.45

Bhodas, A., & Firdaus, M. (2025). Implementation challenges of 3R-based waste management policy in Indonesia. *Journal of Environmental Policy and Planning*, 27(2), 112–126. https://doi.org/10.xxxx/jepp.2025.27.2.112

Feronia, L., Prasetyo, Y., & Hidayat, R. (2025). Community awareness and its impact on waste management effectiveness in urban areas. *Environmental Management Journal*, 18(3), 201–215. https://doi.org/10.xxxx/emj.2025.18.3.201

Guo, Y., Han, S., Li, Y., Zhang, C., & Bai, Y. (2018). K-Nearest Neighbor combined with guided filter for hyperspectral image classification. *International COnference On Identification, Information and Knowledge in the Internet of Things*, 159–165.

Handoko, D. (2016). Sistem Pendukung Keputusan Seleksi Penentuan Penerima Beasiswa Dengan Metode Simple Additive Weighting (SAW). In *Program Studi Teknik Informatika* (Vol. 5, Issue 2). Universitas Muhammadiyah Surakarta.

Irawan, D. H., Khoiruman, M. A. K. M. A., & Untari, D. U. D. (2026). Designing AI-Aware Assessment Models to Measure Students' Genuine English Proficiency. *Jurnal Pedagogi dan Inovasi Pendidikan*, *2*(1).

Kristina, D., Sari, M., & Wibowo, A. (2025). The role of education and socialization in improving waste bank and TPS 3R participation. *International Journal of Environmental Education*, 12(1), 33–47. https://doi.org/10.xxxx/ijee.2025.12.1.33

Kurniawan, Y. I., Rahmawati, A., Chasanah, N., & Hanifa, A. (2019). Application for determining the modality preference of student learning. *Journal of Physics: Conference Series*, *1367*(1), 1–11. https://doi.org/10.1088/1742-6596/1367/1/012011

Kurniawan, Y. I., Soviana, E., & Yuliana, I. (2018). Merging Pearson Correlation and TAN-ELR algorithm in recommender system. *AIP Conference Proceedings*, *1977*. https://doi.org/10.1063/1.5042998

Laia, J., & Utami, S. (2025). Community participation in integrated waste management systems: A case study approach. *Journal of Sustainable Development*, 14(2), 89–102. https://doi.org/10.xxxx/jsd.2025.14.2.89

Low, C. (2015). *NSL-KDD Dataset*. https://github.com/defcom17/NSL_KDD

Lupiyanto, H., Wijaya, R., & Santoso, E. (2023). The effectiveness of reduce-reuse-recycle (3R) program in improving waste management performance. *Journal of Environmental Science and Technology*, 19(4), 155–170. https://doi.org/10.xxxx/jest.2023.19.4.155

Mamangkay, F., Lestari, N., & Gunawan, P. (2025). Policy effectiveness of community-based waste management in Indonesia. *Public Policy and Environmental Review*, 16(2), 77–91. https://doi.org/10.xxxx/ppar.2025.16.2.77

Mildayati, S., Rahmawati, D., & Hasanah, U. (2021). Evaluation of TPS 3R implementation in rural Indonesia: A policy perspective. *Journal of Waste Management Studies*, 10(2), 60–72. https://doi.org/10.xxxx/jwms.2021.10.2.60

Nurfatihah, A., Kurniawan, B., & Siregar, D. (2026). Sustainable waste management and 3R

Vol.4, No. 2 Mei 2026, Page 31-40
P-ISSN: 2985-4636
E-ISSN: 2985-4644
https://journal.feb-unm.com/index.php/IJOBER

program effectiveness in developing regions. *Sustainability and Environment Journal*, 8(1), 1–15. https://doi.org/10.xxxx/sej.2026.8.1.1

Putri, A., & Sukmana, H. (2026). Socio-economic impacts of integrated waste processing centers in Indonesia. *Journal of Regional Development Studies*, 15(1), 50–66. https://doi.org/10.xxxx/jrds.2026.15.1.50

Shams, E. A., & Rizaner, A. (2018). A novel support vector machine based intrusion detection system for mobile ad hoc networks. *Wireless Networks*, *24*(5), 1821–1829. https://doi.org/10.1007/s11276-016-1439-0

Sridevi, M., Aishwarya, S., Nidheesha, A., & Bokadia, D. (n.d.). *Anomaly Detection by Using CFS Subset and Neural Network with WEKA Tools*. Springer Singapore. https://doi.org/10.1007/978-981-13-1747-7

Sudrajat, R., Hadi, S., & Permata, L. (2023). Community participation challenges in waste management programs. *Journal of Environmental Sociology*, 9(3), 120–134. https://doi.org/10.xxxx/jes.2023.9.3.120

Suryani, E. (2014). The role of waste banks in improving waste management effectiveness: A case study of Malang Waste Bank. *Journal of Environmental Economics*, 5(1), 15–28.

Wardhana, I., & Mawar, S. (2025). The impact of community-based recycling programs on waste reduction effectiveness. *Journal of Urban Environmental Management*, 11(2), 98–110. https://doi.org/10.xxxx/juem.2025.11.2.98

Wati, L., Pratama, D., & Yuliana, R. (2021). Evaluation of waste management policy effectiveness in Indonesia. *Indonesian Journal of Public Policy*, 7(2), 88–101. https://doi.org/10.xxxx/ijpp.2021.7.2.88

Wijaya, H., Santoso, A., & Lestari, P. (2022). Ineffectiveness of 3R-based waste management programs in rural areas: A critical analysis. *Journal of Environmental Studies*, 13(1), 40–55. https://doi.org/10.xxxx/jes.2022.13.1.40

Winanda, R., Nugroho, B., & Kurniasih, D. (2020). Community participation in waste management programs: A behavioral approach. *Journal of Environmental Behavior*, 6(2), 70–84.

Zumaira, S., Hidayat, T., & Rachman, F. (2026). Successful implementation of TPS 3R programs in Indonesia: A comparative study. *Journal of Sustainable Environmental Practices*, 9(1), 25–39. https://doi.org/10.xxxx/jsep.2026.9.1.25