

Implementation of the Zero Waste School Program and Analysis of Its Challenges in Vocational High Schools

Suci Dwi Handayani^{1*}, Amestina Matualage², Syafrudin Rahardjo³
Universitas Papua, Indonesia

Corresponding Author: Suci Dwi Handayani;
suci.handayani@student.unipa.ac.id

ARTICLE INFO

Keywords: Zero Waste School, Waste Management, Environmental Education, Implementation Challenges, Sustainable Development

Received : 5 June

Revised : 23 July

Accepted: 30 August

©2026 Handayani, Matualage, Rahardjo: This Is An Open-Access Article Distributed Under The Terms Of The [Creative Commons Attribution 4.0 International](https://creativecommons.org/licenses/by/4.0/).



ABSTRACT

The implementation of zero waste school programs has become increasingly important in Indonesia as an educational approach to address waste management issues. This research analyzes the implementation of the Zero Waste School program and its challenges at SMK Negeri Tandia, Teluk Wondama District, West Papua. This study involved 30 respondents (24 students and 6 teachers) using qualitative descriptive methods with questionnaires, interviews, and field observations. The results showed that the school has successfully implemented waste segregation, reduction of single-use plastics, composting of organic waste, and waste banking systems. However, challenges remain including limited infrastructure, inconsistent student participation, limited budget allocation, and lack of coordination with external parties. The study found that the success of the program depends on the commitment of the school leadership, teacher engagement, student participation, and community support. Recommendations include strengthening monitoring systems, improving teacher engagement through continuous training, allocating adequate budgets for infrastructure, establishing partnerships with relevant environmental agencies, and integrating waste management education more deeply into the curriculum. This research contributes to the understanding of zero waste school implementation in vocational schools and provides practical insights for sustainable waste management education in secondary schools

INTRODUCTION

Waste management has become an increasingly serious and urgent global environmental issue. Each year, the world generates approximately 2.12 billion tons of waste, a figure projected to reach 3.40 billion tons by 2050 in the absence of effective intervention (World Bank, 2022). The growth in waste volume has outpaced existing waste management capabilities, creating an environmental crisis with far-reaching consequences for the sustainability of our planet. Indonesia is one of the world's largest waste generators—ranking second only to China—with waste production reaching 35 million tons annually as of 2024 (Ministry of Environment and Forestry, 2025). This rise in waste volume in Indonesia is driven by rapid population growth (from 275 million to 280 million people), a shift toward increasingly consumerist consumption patterns, and the growing use of single-use products, particularly plastics (Wiranata et al., 2023). These trends are further exacerbated by a lack of public awareness regarding responsible waste management.

The negative impacts of accumulated waste are extensive and multidimensional. Environmental consequences include soil contamination that reduces land fertility, groundwater pollution that endangers clean water sources, air pollution from uncontrolled waste burning, and the accumulation of plastic waste that threatens marine ecosystems. Beyond environmental concerns, poorly managed waste also adversely affects public health by fostering the spread of infectious diseases—such as diarrhea, dengue fever, and malaria—transmitted by vectors that breed in waste piles (Musleh & Rahman, 2024). Respiratory ailments also rise due to air pollution caused by waste. Another dimension of the waste crisis is its contribution to global climate change. The anaerobic decomposition of organic waste generates methane, a potent greenhouse gas with a global warming potential 25–28 times greater than that of carbon dioxide (Rahmat et al., 2023). Thus, waste management is not merely a local environmental issue but also a factor in global climate change. In this context, education plays a crucial strategic role. Schools, as educational institutions, possess immense potential to instill waste management awareness in the younger generation from an early age. Through structured and sustained education, students can be guided to develop environmental awareness and cultivate an eco-conscious character, thereby shaping sustainable lifestyle habits for the future (Hapsari et al., 2025).

One innovative approach developed in various countries—and increasingly adopted in Indonesia—is the Zero Waste School program. According to Saputro et al. (2023), this program is an integrated system involving waste reduction, sorting, reuse, and sustainable processing through the collaborative efforts of the entire school community. This movement has been initiated in countries such as Japan, South Korea, the Philippines, and Thailand, as well as in several Indonesian schools—notably in Bandung, where it was pioneered by Amilia Agustin, a 2010 SATU Indonesia Awards recipient in the environmental category. SMK Negeri Tandia in Teluk Wondama Regency, West Papua, has adopted the Zero Waste School program as part of its efforts to create a sustainable school environment and provide character education to its

students. This initiative reflects the school's commitment to preserving the local environment in Teluk Wondama Regency, an area characterized by a unique and sensitive ecosystem. However, implementation has presented various technical, social, and institutional challenges that require in-depth analysis to identify appropriate, sustainable solutions. Preliminary observations indicate that these challenges include limited waste management infrastructure, inconsistent student participation, a lack of coordination with external stakeholders – such as waste pickers and recycling entrepreneurs – and a limited understanding among some members of the school community regarding the program's importance. A deeper understanding of these challenges and the factors supporting the program will enable the school to develop more effective and sustainable strategies.

This study is designed to conduct an in-depth analysis of the implementation of the Zero-Waste School program at SMK Negeri Tandia, identify factors supporting the program's success, analyze the obstacles and challenges encountered, and examine the efforts undertaken by the school to address these challenges. This research aims to provide a comprehensive understanding of zero-waste school program implementation within a vocational school context, thereby contributing to the literature on environmental education and school-based waste management in Indonesia.

LITERATURE REVIEW

The Zero Waste School is a comprehensive and measurable waste management system aimed at minimizing the volume of waste sent to landfills through the systematic 5R approach: Refuse, Reduce, Reuse, Recycle, and Rot (composting) (Putri et al., 2024). This concept goes beyond mere physical cleanliness or the act of cleaning up trash; rather, it represents a behavioral shift and an environmental cultural transformation that actively and sustainably engages the entire school community. The fundamental philosophy of the zero-waste school is a holistic approach to waste management that integrates three key dimensions: first, the technical dimension, covering the physical management of waste from its source to final processing; second, the educational dimension, focusing on raising awareness and fostering behavioral change; and third, the social dimension, involving the cooperation and commitment of all school stakeholders (Hapsari et al., 2025).

The primary objectives of implementing the Zero-Waste School program include: (1) significantly reducing the volume of waste sent to landfills, with a target reduction of at least 80%; (2) raising environmental awareness and waste literacy among the school community; (3) creating a clean, healthy, safe, and comfortable school environment that supports the learning process; (4) fostering environmental stewardship and social responsibility in students from an early age; (5) lowering school waste management costs through efficiency and reuse; and (6) positioning the school as a driving force for environmental behavioral change within the wider community. This program also aligns with Sustainable Development Goal (SDG) 12 regarding sustainable consumption and production, which emphasizes the importance of prudent resource management. The

successful implementation of the Zero-Waste School program relies heavily on changes in the school community's waste-handling behavior. The most relevant theory for explaining and predicting this behavioral change is the Theory of Planned Behavior (TPB), proposed by Icek Ajzen in 1991. According to the TPB, an individual's behavior is influenced by three interconnected factors: (1) attitude toward the behavior, reflecting an individual's positive or negative beliefs regarding waste sorting; (2) subjective norm, reflecting an individual's perception of social pressure from significant others to either perform or not perform the behavior; and (3) perceived behavioral control, reflecting the perceived ease or difficulty of performing the behavior based on past experience and anticipated obstacles. In the context of school-based waste sorting, a positive environmental attitude, strong social support from peers and respected teachers, and easy access to waste-sorting facilities will encourage students to consistently engage in eco-friendly behavior. Conversely, apathy, unsupportive social norms, and difficult access will hinder student participation in the program.

Another relevant behavioral theory is the Capability-Opportunity-Motivation (COM-B) model proposed by Michie et al. (2011). This model posits that behavior is shaped by a combination of three elements: first, capability (ability), encompassing an individual's knowledge, skills, and physical capacity to perform the behavior; second, opportunity, covering external environmental factors such as the availability of facilities, time, and social support; and third, motivation (drive), comprising the individual's desire or willingness to adopt the behavior. Based on prior research and best practices from schools that have implemented the program, effective implementation of a Zero-Waste School program involves several integrated, essential components: First, adequate and strategically located waste management infrastructure, including clearly labeled waste-sorting bins placed at key locations, composting areas for processing organic waste, waste bank facilities for storing and managing inorganic waste with economic value, and storage areas for residual waste. The availability of this infrastructure is crucial for enabling the school community to sort waste correctly. Second, continuous socialization and education programs for the entire school community regarding the importance of waste management, proper sorting techniques, and the environmental impact of waste accumulation. This education should be delivered through various methods, such as lectures, workshops, hands-on demonstrations, and integration into the academic curriculum.

Third, strategic partnerships with external parties – such as waste pickers, recycling entrepreneurs, and environmental organizations – are essential to enhance the value of recycled products and ensure program sustainability. These partnerships assist schools in selling inorganic waste and provide alternatives for handling waste that is difficult to recycle. Fourth, continuous monitoring and evaluation are required to track program progress, identify emerging obstacles, and adjust strategies accordingly. Monitoring can be conducted through daily waste volume recording, direct observation, and feedback from the school community. Fifth, active and measurable involvement of all school community members is crucial, particularly students, who serve as the primary actors in the

program's day-to-day implementation. This engagement is reinforced through reward systems, incentives, and recognition of student contributions. According to Nabila et al. (2024), the successful implementation of the Zero Waste School program relies heavily on the consistent commitment and leadership of the school principal, the involvement and dedication of teachers acting as facilitators and role models, active and consistent student participation, and support from parents and the local community. Although the Zero Waste School program holds great potential and offers clear benefits, its practical implementation faces various real-world challenges that must be identified and addressed. Previous research indicates that the primary challenges in program implementation include: First, infrastructure and financial resource constraints. Limitations regarding waste management equipment—such as broken composters, the absence of residual waste processing facilities, and insufficient storage space for inorganic waste—pose significant obstacles. Furthermore, limited budget allocations from both the government and the school make it difficult to repair or expand the necessary infrastructure.

Second, there is the challenge of changing behavior and ensuring the participation of the school community. Not all students and teachers share the same level of motivation to participate actively in the program. Student participation rates often fluctuate, particularly when supervision is lax. Some students remain unaccustomed to the waste-sorting system and frequently mix organic and inorganic waste. Third, there is the challenge of environmental awareness. Not all members of the school community possess a high level of environmental awareness. Some teachers and staff still view the Zero-Waste School program as an additional burden on their workload rather than as a shared responsibility to create a sustainable environment. Fourth, there is the challenge of external coordination. Schools face difficulties in finding and partnering with recycling operators capable of managing inorganic waste sustainably at fair prices. Coordination with local government bodies to provide support and incentives for schools implementing the program also remains suboptimal. Fifth, there is the challenge of curriculum integration. The Zero-Waste School program has not yet been fully integrated into the academic curriculum; consequently, students do not gain a deep understanding of waste management and the importance of sustainable development.

METHODOLOGY

The research was conducted at SMK Negeri Tandia, located on Jalan Raya Rasiei-Tandia, Webi Village, Rasiei District, Teluk Wondama Regency, West Papua Province, Indonesia. This school was selected because it has consistently implemented the Zero-Waste School program for over a year and demonstrates a strong commitment to environmental sustainability. The school's semi-rural location presents unique waste management characteristics that differ from those of schools in urban areas. The study was carried out over a three-month period, from January to March 2025. This timeframe was chosen to capture the program's implementation during a relatively stable period—avoiding long school holidays—and to allow the researcher to conduct continuous observations and

in-depth interviews with various stakeholders. A descriptive qualitative approach was employed to gain a deep understanding of the Zero-Waste School program's implementation, the supporting factors, the challenges encountered, and the efforts made to overcome those challenges. This approach was selected because the research aimed to understand a complex social phenomenon from the perspectives of the participants (students, teachers, and school staff) within a specific context. The study population comprised all school community members involved in the Zero-Waste School program, including students, teachers, the principal, and administrative staff. The sample consisted of 30 respondents selected via purposive sampling based on their involvement in the program. The sample included: (1) 24 students from various grade levels (X, XI, and XII) and different vocational specializations, selected based on criteria such as having attended the program orientation and being actively involved in daily Zero-Waste School activities; and (2) 6 teachers directly involved in guiding and implementing the program, comprising supervising teachers, duty teachers, and homeroom teachers. Research data were collected using a combination of three techniques to facilitate data triangulation and enhance the study's validity:

First, questionnaires featuring both closed-ended and open-ended questions were used. Closed-ended questionnaires gathered quantitative data on respondent characteristics (age, gender, duration of study or teaching, and socialization experience), knowledge levels regarding the program, and the frequency of participation in waste-sorting activities. Open-ended questionnaires collected qualitative information concerning respondents' perceptions of the program, the challenges they faced, suggestions for improvement, and their personal experiences. Second, in-depth interviews were conducted with school principals, program-coordinating teachers, and selected students. These interviews aimed to elicit detailed, contextual information regarding program planning and implementation, leadership commitment, the role of teachers in facilitating changes in student behavior, specific practical challenges encountered, and strategies developed to overcome those challenges. Third, structured field observations were carried out to directly observe program implementation in a real-world setting. These observations covered the waste management behavior of the school community, the availability and condition of waste management infrastructure, adherence to the waste-sorting system, routine waste-sorting and processing activities, and interactions among school community members within the program. Observations were conducted at various times of the day (morning, midday, and afternoon) to capture a comprehensive picture.

All data collection was conducted in accordance with research ethics protocols, including obtaining informed consent from respondents and formal approval from school principals and the students' parents. Qualitative data derived from open-ended questionnaires, interviews, and observations were analyzed using a systematic thematic analysis technique. The analysis process comprised the following stages: (1) verbatim transcription of interview recordings, (2) repeated reading of the data to gain a holistic understanding, (3) thematic coding by assigning labels or codes to meaningful data segments, (4)

identification of main themes and sub-themes based on code similarities and differences, (5) development of more abstract thematic categories, and (6) data interpretation to address research questions and relate findings to existing literature. Data from closed-ended questionnaires were analyzed descriptively using frequency distributions and percentages to outline respondent demographics, levels of program engagement, and response patterns. These results are presented in tables and narrative descriptions. The entire analysis took into account the specific school context, the unique local conditions of Teluk Wondama Regency, and the distinct characteristics of the vocational high school (SMK) population compared to regular high schools. Qualitative data processing software was utilized to support the data coding and categorization process.

RESULTS

Research Site Profile

SMK Negeri Tandia is a public vocational high school established in 2007 with the aim of preparing competent human resources in vocational fields to meet the needs of the local and national labor markets. The school offers four specialization programs: Office Management, Institutional Accounting and Finance, Welding Engineering, and Computer and Network Engineering. These specializations were selected to align with the developing local economic potential of Teluk Wondama Regency. In the 2024–2025 academic year, the school has 19 classrooms accommodating approximately 450 students across grades X, XI, and XII, along with 25 educators holding bachelor's degrees and 2 administrative staff members. School facilities and infrastructure include classrooms equipped with whiteboards and desks/chairs, a teachers' room, an administrative office, a principal's office, a library (with a book collection currently being reorganized), a computer laboratory with 30 units, a school canteen, a parking area, a sports field, and adequate restroom facilities.

The school's electricity needs are met via the PLN grid with a capacity of 2,600 watts. However, internet access remains limited and unstable, posing a challenge for the implementation of information technology-based learning. The school facilitates communication through an office telephone line and email to coordinate with the community and various stakeholders. Situated in a semi-rural area of Teluk Wondama Regency, the school operates within a unique environmental context. The region features a sensitive ecosystem with relatively well-preserved natural assets but also faces waste management challenges due to limited waste infrastructure at the regency level. This situation has motivated the school to take the initiative to manage waste independently through a "Zero-Waste School" program.

Characteristics of Respondents and Informants

The study involved 30 respondents, comprising 24 students and 6 teachers. An analysis of respondent characteristics reveals the following:

The distribution by status shows that the majority of respondents (80%) are students, while teachers account for 20% of the total. This composition was selected because students are the group that most frequently interacts directly with the various activities of the Zero-Waste School program in their daily school

lives. Teachers were included in smaller numbers to provide the perspective of program facilitators and supervisors. The gender distribution shows a relatively good balance between male students (46.67%) and female students (53.33%) within the total group of 30 respondents. Among the students, the numbers of males and females were balanced, with 12 of each. Among the teachers, there were more female respondents (4) than male teachers (2). The majority of respondents fall into the 15–17 age group (53.33%) – all of whom are students – followed by the 18–20 age group at 26.67% (students), and the over-20 age group at 20% (teachers). These data indicate that the majority of respondents are adolescents who are still in the process of forming their character and habits. Regarding the duration of their time at the school, 46.67% of respondents have been there for 1–2 years, 23.33% for 3–5 years, 20% for less than one year, and 10% for more than five years. These data suggest that the majority of respondents have been at the school long enough to understand the policies and implementation of the Zero-Waste School program. All respondents (100%) stated that they had participated in an information session regarding the Zero-Waste School program. This indicates that the school has successfully communicated information about the program's objectives, benefits, and implementation to the entire school community.

Implementation of the Zero-Waste School Program

Research indicates that the Zero-Waste School program at SMK Negeri Tandia has been implemented quite effectively, despite facing various challenges. The program's implementation encompasses several key activities:

- a) **Waste Reduction (Reduce):** The school has implemented a policy to reduce single-use plastic consumption by encouraging the school community to bring personal tumblers, lunchboxes, and cutlery from home. This initiative has significantly reduced single-use plastic usage in the school canteen. Paper usage in administrative tasks has also been minimized by shifting to digital media and electronic record-keeping systems.
- b) **Waste Segregation (Segregation):** Waste at the school is sorted into three main categories: organic, inorganic, and residual. The school provides color-coded waste bins at strategic locations, including classrooms, the canteen, the teachers' lounge, and learning areas. Each bin is clearly labeled to assist the school community in disposing of waste into the correct category.
- c) **Organic Waste Processing (Composting):** Organic waste – such as food scraps from the canteen, leaves, grass clippings, and fruit peels – is collected separately and composted using enclosed composters located on the school grounds. The resulting compost is used to nurture ornamental plants and vegetables in the school garden, thereby creating a sustainable cycle.
- d) **Waste Bank:** Inorganic waste with economic value – such as plastic bottles, cardboard, paper, glass bottles, and cans – is collected separately, cleaned, and stored at the school's waste bank. This waste bank system incentivizes students who actively participate in waste collection by awarding points that can be exchanged for prizes or used to gain extra credit in assessments.

- e) Routine Activities: The program is carried out through daily, weekly, and monthly activities. Daily activities include picking up litter, cleaning classrooms, checking segregated waste bins, and ensuring proper waste sorting. Weekly activities include "Clean Friday" (a comprehensive cleanup of the school grounds), as well as classroom cleanliness inspections and plant maintenance. Monthly activities include program evaluation, recording waste volume, presenting awards to the cleanest class and the most active student, as well as environmental outreach and education.

Implementation Challenges

Although the program has proceeded reasonably well, research has identified several significant challenges affecting its effectiveness:

1. Infrastructure and Budgetary Challenges: Limited waste management equipment and facilities pose a major, tangible obstacle. Some composting units are broken and beyond repair due to school budget constraints. The budget allocated to the program from the School Budget (APBS) represents only about 5% of the total education budget – far less than what is actually required. There are no dedicated facilities for processing residual waste, which ultimately still has to be sent to a final landfill. Limited storage space at the waste bank also frequently leads to the accumulation of inorganic waste.
2. Inconsistent Student Participation Challenges: Student participation levels remain volatile and inconsistent. Observations indicate that compliance with waste sorting is higher when teachers or program organizers are supervising (around 85%) but drops drastically when supervision is reduced (to just 40%). Some students still frequently fail to sort waste correctly, particularly during specific times such as recess or when the teacher on duty is not present. Student motivation to participate is also influenced by their understanding of the program's importance.
3. Environmental Awareness Challenges: Not all members of the school community possess a high level of environmental awareness regarding the importance of sustainable waste management. Some teachers and staff still view the Zero Waste School program as an additional burden on their routine duties rather than a shared responsibility to create a sustainable environment. Some students hold the view that waste is a problem for cleaning staff to handle, rather than a responsibility of their own.
4. External Coordination Challenges: The school faces significant difficulties in finding recycling partners capable of managing inorganic waste sustainably while offering fair prices. There is currently no formal collaboration with recycling businesses or waste collectors at the regency level. Coordination with local government, the Environmental Agency, and environmental organizations remains suboptimal in terms of providing full support, training, and incentives for the school program. The absence of local regulations supporting the program leaves the school to struggle on its own.
5. Challenge of Limited Knowledge: Some teachers and students still possess limited knowledge regarding proper waste management techniques, particularly concerning correct composting methods and safe

recycling practices. There is also a lack of training for the teachers supervising the program, meaning they often have to learn as they implement it.

School Efforts to Address Challenges

Despite facing significant challenges, the school has implemented various innovative and sustainable measures to enhance program effectiveness:

1. Continuous Outreach and Education: The school consistently conducts outreach regarding the importance of waste management for students and teachers, at least twice a month. Educational programs are delivered through various methods, such as classroom lectures, demonstrations of proper waste sorting, screenings of documentaries on the impact of waste, and group discussions. Outreach efforts are also integrated into relevant subjects like Biology, Geography, and Local Content curricula. Students receive instruction on the "5R" principles and the environmental impact of waste accumulation.
2. Awards and Incentive Systems: The school presents monthly awards to the cleanest classes that consistently practice waste sorting. Students who are most active in the program receive certificates and bonus points in their behavioral assessments. A waste bank awards points to students who collect inorganic waste; these points can be exchanged for useful items or a small allowance. This incentive system has proven effective in boosting student motivation to participate actively and consistently.
3. Continuous Monitoring and Evaluation: The school conducts daily monitoring through cleaning staff and duty teachers who directly inspect the condition of trash bins and the tidiness of the school grounds. Daily records are kept to document the volume of waste generated and successfully managed. Monthly program evaluations involve all stakeholders to assess progress, identify obstacles requiring resolution, and plan corrective actions. Evaluation results are communicated back to the school community to ensure transparency and accountability.
4. Phased Infrastructure Improvements and Additions: The school continuously strives to improve and expand waste management facilities within the limits of its available budget. These efforts are funded by the School Budget (APBS) allocation for environmental programs, as well as through proposals submitted to the school committee and parents for additional contributions. Infrastructure improvements include the installation of sorted waste bins in strategic locations and the upgrading of waste bank facilities.
5. Active Leadership by the School Principal: The principal demonstrates consistent commitment to the program through tangible actions, such as allocating a budget, participating in "Clean Friday" activities, and recognizing students and teachers who excel in the program. This commitment serves as a model for the entire school community.
6. Collaboration with Parents and the Community: The school has begun involving parents in the program through educational letters and by encouraging them to support their children in bringing personal reusable

eating and drinking utensils. Some initiatives also involve parents in school environmental cleanup activities.

DISCUSSION

The findings of this study indicate that the implementation of the Zero-Waste School program at SMK Negeri Tandia reflects the school's genuine commitment to environmental sustainability and character education. The program has successfully adopted a systematic 5R approach, specifically regarding the reduction of plastic use, organized waste sorting, organic waste composting, and a waste bank system. These results align with the findings of Saputro et al. (2023), which demonstrate that a systematic and integrated approach to waste management can foster a shift in environmental culture within schools, particularly when the entire school community is involved. However, the challenges faced by the school are also consistent with previous research indicating that implementing a Zero-Waste School program is neither an easy nor a linear process. Infrastructure and budgetary limitations represent real obstacles faced not only by SMK Negeri Tandia but also by many other schools in Indonesia – especially those in non-urban areas where resource constraints are often more severe (Nabila et al., 2024). Fluctuating student participation levels reflect the reality that changing environmental behavior requires significant time, consistent reinforcement, and sustained motivation. As explained by the Theory of Planned Behavior (Ajzen, 1991), individual behavior is influenced by attitudes, social norms, and perceived behavioral control. In this context, the observation that waste-sorting compliance is high under supervision but declines in its absence suggests that students have not yet fully internalized environmental values; instead, their actions remain heavily influenced by external control.

The measures implemented by the school – particularly continuous awareness-raising, reward systems, and rigorous monitoring – demonstrate a sound understanding of the importance of combining external and internal motivation to drive behavioral change. However, to ensure genuine long-term sustainability, it is necessary to further cultivate students' intrinsic motivation through more comprehensive environmental values education and the full integration of the program into the daily curriculum. Limited external coordination also poses a significant obstacle to the program's sustainability. The school's experience aligns with research by Najiyah et al. (2025), which indicates that support from local government, environmental agencies, and recycling businesses is crucial for creating an ecosystem that fosters a zero-waste school program. Without strong, sustained partnerships, the school is forced to tackle challenges on its own – challenges that actually require systemic solutions at a broader level.

CONCLUSIONS AND RECOMMENDATIONS

The Zero Waste School program at SMK Negeri Tandia has been successfully implemented in a structured manner, engaging the entire school community in sustainable waste reduction, sorting, processing, and recycling activities. By adopting the comprehensive 5R approach (Refuse, Reduce, Reuse,

Recycle, and Rot), the school has established an effective waste management system and fostered environmental awareness among students. However, the program still faces significant challenges that require serious attention to ensure its long-term sustainability. Key challenges include limited infrastructure and budget, inconsistent student participation, low environmental awareness among some members of the school community, a lack of coordination with external parties, and limited integration of the program into the academic curriculum. The school's initiatives – particularly regarding ongoing awareness-raising, incentive systems, active monitoring, and phased infrastructure improvements – demonstrate a strong commitment to the program. Nevertheless, these efforts need to be enhanced through strategies that are more integrated and well-coordinated, while also engaging various stakeholders, including local government, the community, and the business sector.

FURTHER STUDY

Based on the results of this study, the following recommendations are proposed to enhance the effectiveness and sustainability of the Zero-Waste School program at SMK Negeri Tandia and other schools:

1. For Schools: (a) Increase budget allocations for waste management infrastructure through various funding sources, including the school budget (APBS), proposals to the school committee, and parental contributions; (b) Develop a curriculum that integrates waste management and environmental sustainability into various subjects; (c) Conduct continuous training for supervising teachers on innovative environmental teaching methods and proper waste management techniques; (d) Establish formal partnerships with recycling businesses and local waste collectors to increase the economic value of recycled products; (e) Engage parents and the local community more intensively in the program through joint activities and family education.
2. For Local Government: (a) Allocate specific funds to support the implementation of the Zero-Waste School program across various schools through subsidy mechanisms or incentive funds; (b) Establish local regulations supporting the implementation of the Zero-Waste School program and provide incentives to schools that successfully meet waste reduction targets; (c) Involve the Environmental Agency in providing technical support, training, and coordination among relevant stakeholders; (d) Facilitate the formation of a Zero-Waste School network to enable the sharing of experiences and lessons learned among schools.
3. For Researchers and Academics: Conduct further research on the long-term impact of the Zero-Waste School program on the environmental behavior of students and their families, and analyze the effectiveness of various motivational strategies in maintaining consistent student participation.

Research Contributions and Implications

This study makes a significant contribution to the understanding of Zero-Waste School program implementation within the context of vocational schools in Indonesia, particularly in non-urban areas. The findings indicate that, despite significant challenges, the Zero-Waste School program holds great potential to

contribute to changes in environmental behavior and sustainable development at the school level. The practical implication is the need for a systemic approach involving various stakeholders to ensure the program's long-term sustainability.

REFERENCES

- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211.
- Hapsari, W., Setiawan, D., & Pratama, B. (2025). Peran guru dalam pendidikan lingkungan berkelanjutan di sekolah menengah. *Jurnal Pendidikan Lingkungan*, 12(1), 45-62.
- Kementerian Lingkungan Hidup dan Kehutanan. (2025). Laporan pengelolaan sampah Indonesia tahun 2024. Jakarta: Direktorat Jenderal Pengelolaan Sampah, Limbah dan Bahan Beracun Berbahaya.
- Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science*, 6(1), 42.
- Musleh, S. & Rahman, M. A. (2024). Waste management and human health: A systematic review of environmental health impacts. *Environmental Pollution*, 315, 121234.
- Nabila, S., Suryanto, A., & Wijaya, N. (2024). Kesadaran masyarakat terhadap pengelolaan sampah di kawasan perkotaan Indonesia. *Jurnal Lingkungan dan Pembangunan Berkelanjutan*, 18(2), 123-145.
- Najiyah, F., Rustiadi, E., & Hadi, S. (2025). Faktor-faktor penentu keberhasilan program sekolah nol sampah di sekolah menengah atas. *Jurnal Administrasi Pendidikan*, 8(1), 78-95.
- PT Astra International Tbk. (2018). Go to zero waste school: Inisiatif kesadaran lingkungan dan tanggung jawab sosial perusahaan di era modern. Jakarta: Corporate Social Responsibility Division.
- Putri, Y., Susanto, R., & Mardhani, M. (2024). Implementasi pendekatan 5R dalam pengelolaan sampah sekolah berkelanjutan. *Jurnal Teknologi Lingkungan*, 14(2), 156-174.
- Rahmat, A., Ismail, I., & Kusuma, A. (2023). Emisi gas rumah kaca dari pengolahan sampah organik dan strategi mitigasi perubahan iklim. *Jurnal Perubahan Iklim Indonesia*, 9(3), 267-285.
- Saputro, E., Santoso, A., & Widodo, H. (2023). Zero waste school sebagai pendekatan edukatif dalam pembangunan berkelanjutan. *Jurnal*

Pendidikan Berkelanjutan dan Ramah Lingkungan, 11(4), 212-230.

Wiranata, R., Pratama, G., & Hardianto. (2023). Permasalahan sampah global dan solusi pengelolaan terpadu yang berkelanjutan. *Jurnal Ilmu Lingkungan*, 16(1), 89-108.

World Bank. (2022). *What a waste 2.1: Managing waste in a changing world*. Washington, DC: World Bank Group Publications.