

Optimizing Repair and Maintenance of Waste-Processing Machinery for Sustainable Environmental Management in Pariaman City

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Abstract

This study addresses persistent waste-management challenges in coastal urban areas by optimizing the performance of waste-processing equipment at the Reduce-Reuse-Recycle (TPS3R) facility in Pariaman City. It was conducted through a Reliability-Centered Maintenance (RCM)-based repair and preventive maintenance program. The intervention combined field observation, identification of critical components, operator technical training, and the implementation of a structured maintenance schedule adapted to local operational conditions. Implementation involved collaboration among TPS3R management, local community members, and technical staff from Politeknik Pelayaran Sumatera Barat. Data were collected through direct observation, semi-structured interviews, and documentation of maintenance activities. Post-intervention evaluation demonstrated substantive gains in machine processing efficiency, up to an 80% improvement relative to baseline and a marked reduction in breakdown frequency. Operators showed measurable increases in technical competence and consistent adherence to Standard Operating Procedures (SOPs) for safe and effective machine operation. The findings underscore the value of vocational higher-education-community partnerships for technology adaptation, capacity building, and fostering a maintenance culture that supports sustainable urban waste systems. The program represents a scalable, replicable model for similar coastal contexts and contributes to Sustainable Development Goals 11 (Sustainable Cities and Communities) and 12 (Responsible Consumption and Production).

Keywords: Repair and Maintenance, Waste-Processing, Machinery, Sustainable Environmental Management, Community Service

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INTRODUCTION

Pariaman City has the potential for excellent economic, social, and tourist development being a coastal area of West Sumatra Province. Within the last few years, significant community activities in terms of tourism and fisheries development have been driving growth. However, these activities are also increasing awareness of waste generation within the urban and coastal areas. According to data obtained from the Environmental Agency of Pariaman City in 2024, the production of waste reached about 70 tons per day, deriving mainly from household waste, traditional markets, and tourist areas. This data shows that the system of waste management in Pariaman City is still not effective. Its main problem is the less-than-optimal use and maintenance of the provided machine for processing wastes by the local government. Most of the wastes still end up in landfills without adequate processing. This condition seriously affects the cleanliness of the environment and the quality of life of the surrounding community.

The Pariaman City Government has actually attempted to procure several organic and inorganic waste processing machines located at the Integrated Waste Processing Site (TPST) and the 3R Waste Processing Site (TPS3R). These machines are designed to shred, sift, and process waste into compost and other recyclable materials. Unfortunately, in practice, many of the machines experience operational problems due to a lack of routine maintenance and a limited number of competent technical personnel. Due to overuse without routine maintenance, mechanical components and electrical systems commonly suffer damage. This machine damage slows down the processing process and causes residue to build up in landfills. When waste cannot be processed properly, the potential for water and soil pollution increases.

Machine maintenance, in these conditions, is highly essential as it helps in the sustainability of the waste processing system within Pariaman City to further support the concept of a clean and sustainable city. One of the root causes of low effectiveness in machine maintenance is the lack of technical skills among operators. The majority of operators working at the TPS3R do not have sufficient skills in performing preventive or corrective maintenance. Maintenance is mostly reactive; this means that it is only carried out after an occurrence of damage. On the other hand, a preventive approach has the potential to decrease the possibility of damage by 40%, as explained by Fadillah et al. (2021), limited training and technical assistance are very often followed by inadequate functioning of the machines and require a long time for repairs. This condition worsens work efficiency and ensures high operational costs.

Therefore, an improvement in the technical competence of operators is an urgent necessity through structured training programs. Politeknik Pelayaran Sumatera Barat (Poltekpel Sumbar), as an academic partner with technical competence in mechanics, electricity, and machinery systems, is present to take part in helping solve the problem through community service activities. Besides technical aspects, machine management problems are also caused by a lack of scheduled maintenance system and proper documentation of maintenance activities. Many machines in TPS3R do not have well-documented operational records and repair histories. Prediction of potential damage or setting a schedule for service is quite difficult to perform. According to Syahputra, Pradana, and Bachtar (2020), the web-based preventive maintenance system will enhance the accuracy of the maintenance schedule while reducing machine downtime up to 25%. Thus, the implementation of condition-based maintenance according to the schedule and condition of the machines (condition-based maintenance) is required at TPS3R, Pariaman City. With such a system, the maintenance activity is able to be performed routinely, measurably, and efficiently so that the continuity of machine operation can be assured in the long run.

In the efforts to optimize waste processing machine repair and maintenance activities, it pays attention not only to technical but also social and educational dimensions. In managing a clean and healthy environment, there is a need for joint collaboration between the government, academics, and the community. In fact, the active involvement of the public, both in sorting waste from the source and in their awareness of the importance of processing equipment maintenance, is one of the determining factors for the success of the program itself. Community service activities enable Poltekpel Sumbar to integrate educational approaches through outreach, training, and technical assistance. This framework enables synergy between technical knowledge and public understanding for the waste management system to be participatory and sustainable.

The West Sumatra Maritime Polytechnic has a strong potential to enhance environmental management initiatives in Pariaman City. The skills of both lecturers and students in areas such as marine mechanical engineering, power transmission systems, refrigeration, and electricity can be utilized for the upkeep of waste processing equipment. There are key similarities between the operational principles of marine engines and waste processing machines, particularly in terms of maintaining mechanical efficiency and system stability.

By adopting a vocational approach, Poltekpel Sumbar can offer practical solutions to the technical challenges faced by TPS3R managers. This partnership also allows students to apply their classroom knowledge in real-world settings, bridging the gap between theory and practice in vocational education. The community service initiative aims not only to repair and maintain the machinery but also to generate meaningful academic outputs. These outputs may include the creation of technical training modules, Standard Operating Procedures (SOP) for machine operation and maintenance, and a maintenance log system for regular use. Additionally, this initiative promotes the publication of community service findings in national scientific journals, helping to spread knowledge to a broader audience. With these documents and publications, the sustainability of the

initiative can be ensured, and the waste processing machine management model can be replicated in other similar regions.

From an environmental standpoint, enhancing the repair and maintenance of waste processing machines is expected to boost operational efficiency, prolong their lifespan, and lessen the strain on landfills. Well-functioning machines can speed up the waste processing process, generate quality compost, and minimize harmful gas emissions. Therefore, this initiative aligns with the principles of a Circular Economy, which focuses on resource reuse and waste reduction. Furthermore, improving machine performance will also enhance the cleanliness and visual appeal of the city, reinforcing Pariaman City's status as a prominent, environmentally aware marine tourism destination.

Implementing this activity comes with several challenges that cannot be overlooked. A significant hurdle is the scarcity of machine spare parts in the local market, as most waste processing machines rely on imported components that are hard to source. This situation leads to lengthy and costly repairs. To address this issue, Poltekpel Sumbar intends to research and innovate local substitutes for these components, aiming to streamline the maintenance process. Additionally, ongoing support from the local government is crucial for the maintenance program's success. Establishing a local technical team coordinated by the Pariaman City Environmental Agency (DLH) is a strategic move to ensure the sustainability of this initiative.

In summary, the Optimization of Repair and Maintenance of Waste Processing Machines for Sustainable Clean Environmental Management in Pariaman City exemplifies a collaborative effort among the education sector, government, and community to tackle environmental challenges. By adopting a participatory and practical approach, this initiative aims to develop an efficient, eco-friendly, and sustainable waste management system. The program not only enhances machine performance but also empowers the community and boosts the skills of the local workforce. With the active participation of all stakeholders, Pariaman City can serve as a model for technology-driven environmental management and education that aligns with the goals of sustainable development (SDGs).

METHOD

The community service activity utilized a participatory-applicative method, specifically Participatory Action Research. This approach integrates technical, educational, and collaborative efforts among academics, local government, and the managers of the Integrated Waste Processing Facility (TPST) and TPS3R in Pariaman City. It encourages active participation from all stakeholders in identifying issues, executing activities, and evaluating outcomes. The implementation process involved several stages, starting with an initial survey of machine conditions, followed by technical planning, operator training, establishing a scheduled maintenance system, and evaluating machine performance post-repair.

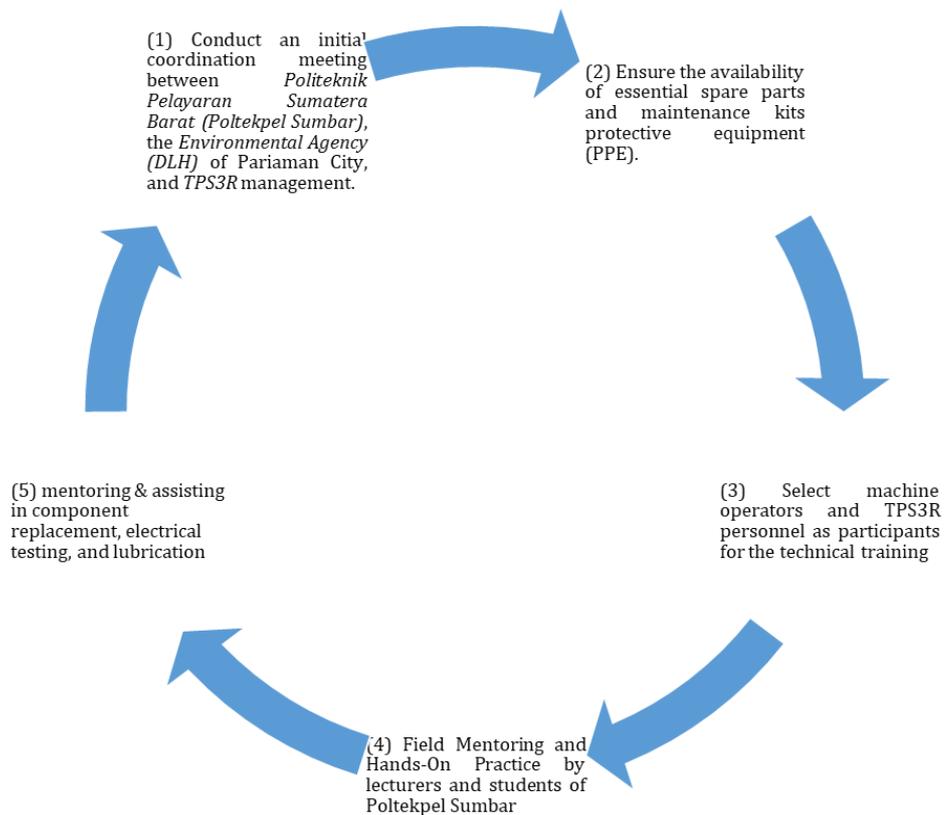


Figure 1. Community Service Activity Flow

Initially, a team from the West Sumatra Maritime Polytechnic worked with the Environmental Agency and TPS3R managers to assess machine damage and set maintenance priorities. They developed Standard Operating Procedures (SOPs) and training modules to assist operators in performing preventive maintenance. The training employed a hands-on learning approach, allowing participants to gain practical experience with guidance from instructors and cadets, ensuring that the knowledge and skills acquired were relevant to the technical demands of the field. Subsequently, the team carried out machine repairs and maintenance at partner TPS3R sites, focusing on both mechanical and electrical systems. They replaced essential components, inspected the power transmission system, cleaned filters, and calibrated measuring instruments to ensure machines operated within specifications. At the same time, operators were trained on how to complete maintenance logs and perform daily inspections. Periodic evaluations were conducted to measure improvements in the operators' technical skills and the effectiveness of the maintenance system. Monitoring results indicated a significant reduction in machine breakdowns and an increase in operational efficiency. Additionally, the activity included the creation of technical reports and scientific publications to share the results of the community service. Overall, the participatory-applicative method not only aimed for technical outcomes, such as machine repairs, but also focused on creating a sustainable work system by enhancing human resource capabilities and fostering a collaborative model between academics and the community.

RESULT AND DISCUSSION

The community service program aimed at optimizing the repair and maintenance of waste processing machines in Pariaman City yielded notable improvements in both the

technical performance of the equipment and the skills of local operators. This initiative was a collaborative effort involving Poltekpel Sumbar, the Department of Environment (DLH) of Pariaman City, and the management of the 3R Waste Processing Site (TPS3R). The project commenced with a survey to evaluate the condition of the existing waste processing machines, such as shredders, composters, and sorting machines. The survey indicated that about 65% of the machines had reduced efficiency due to inadequate lubrication, mechanical wear, and insufficient preventive maintenance. In response to these findings, the team developed a series of technical interventions that included mechanical adjustments, electrical repairs, and the reinstallation of essential components. This preparatory phase ensured that the subsequent repair and training activities were grounded in accurate field data and diagnoses. As a result, the project effectively combined technical and educational goals, merging applied engineering practices with capacity building for sustainable operations.

During the training phase, instructors and cadets from Poltekpel Sumbar conducted an extensive technical workshop on the operation and maintenance of waste processing machines. The training consisted of 50% theoretical instruction and 50% practical exercises, ensuring that participants grasped both the theoretical concepts and practical applications of machine maintenance. They learned about routine inspections, oil changes, filter cleaning, component alignment, and safe operating procedures. The training emphasized a hands-on approach, allowing operators to perform maintenance tasks under supervision. This practical experience greatly enhanced their confidence and skill level, enabling them to address minor mechanical and electrical issues independently. Evaluation results indicated that 90% of participants could accurately identify early signs of malfunction and take preventive measures. Additionally, participants were introduced to the idea of maintaining a logbook to track inspection schedules and machine conditions, providing a useful reference for future maintenance. Overall, the training laid a solid foundation for fostering local technical independence in the operation of waste processing machines.

Following the training, the project entered the technical implementation stage, focusing on the real-time repair and maintenance of the TPS3R machines. This included tasks such as cleaning and adjusting mechanical components, fixing power transmission belts, calibrating sensors, and repairing damaged electrical circuits. Each repair was recorded on a technical maintenance sheet, which outlined the issues faced and the solutions applied. The machines were also tested under load to verify their performance stability. The post-repair assessments showed a significant improvement in the efficiency of the shredding and composting processes, with operating speeds nearing optimal levels. Additionally, downtime was greatly reduced, dropping from an average of four breakdowns per month to just one. This progress was linked to the introduction of preventive maintenance schedules and enhanced operator awareness. The participation of Poltekpel Sumbar cadets added value, as they gained practical experience in mechanical maintenance relevant to both maritime and environmental equipment.

To evaluate the program's effectiveness, both quantitative and qualitative measures were used. On the quantitative side, there was a 25% increase in machine operation efficiency and a 75% decrease in unexpected machine downtime. Qualitatively, interviews with operators and TPS3R management revealed a significant improvement in their understanding of the importance of maintenance and safe machine operation. These findings are consistent with earlier research by Wibowo (2022), which indicated that field-based training greatly improves vocational skills in environmental management. Furthermore, the project illustrated that maintenance-focused interventions can lead to immediate environmental benefits by reducing the buildup of unprocessed waste. With enhanced machine reliability, TPS3R was able to handle a larger volume of waste daily, thus alleviating pressure on landfills. The combination of hands-on training and structured

maintenance procedures stood out as a successful strategy for sustaining long-term performance. It also emphasized the need for continuous monitoring within a comprehensive maintenance system. This stage confirmed that technical improvement and human resource development must go hand in hand to make operations sustainable.

From an environmental point of view, the improved machine functionality contributed directly to cleaner surroundings and reduced pollution. If machines are functioning well, the volume of wastes to be moved to their final disposal sites drastically decreases. This reduces the risk not only of soil and groundwater pollution but also enhances aesthetic conditions in the surroundings. The compost generated after machine optimization proved to be more homogeneous and decomposed much faster than before the intervention. Therefore, this improvement is evidence that technical efficiency has a direct consequence on environmental quality within the premises of the waste management facility. Moreover, the improvement in air quality around the TPS3R site was managed to reduce piles of organic waste that previously created odors. This kind of environmental gain proves that a technical maintenance program encompasses a wider scope than just the machinery. Hence, this successful implementation in Pariaman City acts as an illustration of applied engineering in maintaining ecological balance. The project contributed to attaining the SDGs at Goal 11 regarding sustainable cities and communities.



Figure 2. The instructor provided instructions on operating the waste processing machine control panel to the training participants.

In this photo, a technician is explaining the operation of a machine for the processing of waste to several team members. This activity is an example of the kind of practical approach used in optimizing the repair and maintenance of the machines, ensuring that they are efficient and safe to work with. It gives a focus on training and technical guidance, which plays an important role in developing the competence of the local operators who will manage this equipment daily. This initiative by Pariaman City targets the importance of preventive maintenance to avoid breakdowns and operational damage. The early detection of malfunction could be regularly inspected on control panels and mechanical components, as could be seen from the picture of the activity. This preventive maintenance culture reduces the repair cost of the equipment and extends its life. Moreover, this joint collaboration by the team shows a shared commitment to the sustainability of a clean environment. Such sessions are an important part of maintaining consistency and safety standards in waste management operations.

The picture is symbolic of the city's effort to integrate modern technology with environmental awareness. The inspection of the waste processing machine that plays a core

role in reducing the volume of solid waste reaching landfills is critical to the community for ensuring continuous waste treatment processes supportive of a clean and healthy urban environment. This will be a process in tune with global goals pertaining to sustainable cities and communities for encouraging eco-friendly practices. It nurtures not only technical expertise among these workers but also a sense of responsibility for taking care of the surroundings. Every component of the maintenance routine, from the calibration of the control system to the diagnostics of the engine, was representative of steps towards achieving efficiency in waste conversion. The city government's investment in such capacity-building activities reveals a long-term vision for sustainability. Regular maintenance and optimized machine operation can make Pariaman a role model for other regions in Indonesia to aim for eco-friendly waste management systems.

Finally, the fact that the activity involves many participants in terms of collaboration indicates teamwork and learning processes. That kind of technical engagement lays a better ground for further maintenance and innovation in managing waste in the future. The individuals involved are not just operators; they act as agents of environmental change whereby technology is made to serve the community through them. Their attention to machine detail, precision of calibration, and operation safety standards underscores the city's modern approach toward managing waste. With Pariaman enhancing its local technical capacity, it becomes more self-sufficient in its efforts toward sustainable waste management. This objective lessens the reliance on external support and, at the same time, fosters creativity within the local people. It is, therefore, an important step toward the ultimate goal of maintaining a sustainable, clean city with environmental consciousness. The act of optimization and repair, therefore, does not stop at a technical level but is a movement of transformation toward caring for the environment.



Figure 3. The community service team, Pariaman City DLH, and TPS3R managers after the technical training activity.

This photo represents a team of engineers, technicians, and local government representatives posing together after a successful session on maintenance and training. This group effort is evocative of the partnership that has shaped the optimization of the waste processing system in Pariaman City. With members ranging from field operators to supervisory personnel, this represents the integrated approach needed to maintain a sustainable waste management framework. In this way, their collective gesture of unity and commitment serves as a representation of a vision for environmental sustainability. Such group coordination is important in ensuring that every aspect of personnel understands their role in keeping the machinery running. The unity evident in the photo suggests that

teamwork lies at the heart of long-term approaches to waste management. Moreover, the setting within the waste processing facility provides a sense that the project is practical and community-centered. In any case, the initiative embarks upon the view that environmental management is a shared affair; thereby, necessitating technical skill and civic commitment.

This moment signifies the success of capacity-building programs that aim at enhancing local expertise in machine maintenance. Training ensures self-sufficiency of the team for diagnostics, mechanical repairs, and efficiency control of the machines. By empowering local technicians, the city will prevent the prospect of negligence of its equipment and operational inefficiencies. The fact that the facility is clean and well-organized presents the effectiveness of the maintenance protocol put in place. Such systematic approaches contribute to minimizing waste accumulation and enhancing the aesthetic quality of urban areas. Moreover, the knowledge shared in this session will likely be distributed to other units that handle waste management, further scaling up the impacts of this program. The active involvement of the government underlines its commitment to the implementation of environmental policy and sustainable urban development. Because of this, Pariaman becomes an exemplary city in finding a balance between technological advancement and ecological preservation. This photo captures the moment of cooperation, skill development, and environmental dedication.

This group photo is the realization of the perfect finish and a promising future in sustainable waste management in Pariaman. The confident stance of the participants projects pride in having contributed to keeping the surroundings clean. It serves as motivation for constant improvement in machine maintenance and care for the environment. Through further training and continuous upgrading of the system, the waste processing plant will serve as an important infrastructure for a green and sustainable city. This teamwork culture enables any challenge with machine operation to be resolved collectively. Technical teams and local authorities are on the same page to ensure the sustainability of the program in the long run. Furthermore, this will provide a platform for future innovations in Waste-to-Energy or Recyclable technologies. The picture captures not only the technical feats but also human spirit behind Pariaman's efforts toward a clean and sustainable community with due respect to the environment.



Figure 4. The technician team checked the air pressure using a compressor to support the mechanical equipment maintenance process.

In this picture, a crew of techies and learners is busy fixing stuff with an air pump and repair gear. This moment marks a crucial step in fine-tuning the repair and upkeep of the waste processing machine. People are seen adjusting and cleaning parts of the machines to make sure everything runs smoothly and efficiently. Such practical maintenance activities are essential to prevent operational breakdowns and maintain consistent performance. The city's dedication to teamwork and skill sharing shows they're really invested in boosting local tech skills. Participants pick up how to use gear safely and

responsibly, and that's a big help for keeping things sustainable Regular upkeep with air pressure gadgets cleans out gunk, dust, and leftover waste from the parts of machines This makes sure the machines keep on working smoothly to handle the trash without any hiccups This activity also boosts teamwork between seasoned engineers and newbies, fostering a sharing of know-how for upcoming projects.

The picture shows how tech and learning come together in managing our environment By involving both professionals and learners, the maintenance activity serves as a capacity-building exercise for sustainable waste processing. The picture shows a compressor that's all about being efficient and innovative when it comes to keeping industrial gear running smoothly Keeping the waste processing machine well-maintained lowers the chance of breakdowns and helps it last longer This backs up Pariaman's aim to keep the city clean and free from pollution The clear signs of teamwork, concentration, and technical skill show a wider culture of caring for the environment growing in the area The city's smart strategy for keeping its gear in tip-top shape cuts down on expenses and trash pile-up Plus, this project shows how tech and training can join forces for a greener future This hands-on exercise shows how the maintenance concepts we learn in tech courses play out in the real world.

Also, the way the team worked really highlights how social aspects are key to sustainable development The teamwork between tech gurus, students, and bosses really shows how the project embraces everyone Pariaman boosts its ability to handle the environment for the long haul by teaching local workers how to fix and diagnose machines Keeping up with regular maintenance like this not only keeps things running smoothly but also keeps everyone safe at work Everyone's effort helps us keep our city clean and green by making sure machines work well The picture represents dedication, self-control, and caring for our planet, all crucial for sustainability Maintenance's not just about the nuts and bolts; it's really about looking after our shared spaces Teh upkeep of our gear fits right into the idea of cities that are all about keeping things green while still getting the techie stuff done Pariaman City keeps pushing forward with its plans to create a waste management system that's both eco-friendly and self-reliant.



Figure 5. The officer fills the generator engine oil as part of routine maintenance to ensure optimal performance.

In this photo, two technical personnel are seen conducting a maintenance activity on a waste processing machine at the TPS3R facility in Pariaman City. One of them is holding a hose connected to a container of engine oil, while the other is assisting by ensuring that the oil enters the engine properly. This process represents one of the important steps in preventive maintenance, where regular lubrication seeks to reduce mechanical friction and extend the operational life of the machine. The individuals are

fitted out with all standard personal protective equipment, including helmets, gloves, and safety shoes, in conformity with occupational safety standards. The action represents one of the field implementations of the report through the optimization of the maintenance system of waste processing machines, to ensure efficient operation and sustainability.

This photo of the maintenance process accentuates vocational knowledge application by lecturers and students from Politeknik Pelayaran Sumatera Barat during their fieldwork. The lecturers and students participated hands-on in the checking and maintenance of the engine's lubrication system, hence applying the basic principles of mechanical engineering in serving the community. This relates to the description of the participatory action research method, wherein academic experts and operators collaborate in solving operational problems. The operators also get to learn through observation and practice during such practical tasks, which enhance their machinery care knowledge. This is the educative and collaborative instance of the community service project.

The photo shows some activities that are part of the bigger objective to improve operator competency and institute scheduled preventive maintenance at TPS3R. The exercise equips local waste facility operators with the ability to perform routine servicing in order to minimize the frequency of machine breakdowns and reduce machine downtime. The photo, therefore, illustrates how small yet consistent maintenance actions in the form of oil replacement and lubrication can go a long way in increasing machine performance. This goes in line with the emphasis on sustainability in the report, with well-maintained machines translating to better outcomes in waste processing and reduced environmental pollution. The picture represents technical discipline and teamwork as critical ingredients in realizing an effective waste management system.



Figure 6. The Poltekpel Sumbar team together with the TPS3R operator checked the electrical system of the waste processing machine in Pariaman City

The picture shows a training and supervision meeting with a bunch of people in helmets, all huddled around a machine control setup. A tech from Politeknik Pelayaran Sumatera Barat is showing us how to check and test the electrical bits of the battery system in the trash processing machine. This activity represents one of the essential technical trainings outlined in the implementation phase of the report, ensuring that operators understand the electrical systems supporting machine operation. When you're checking the battery connections, voltage levels, and cable condition, you're getting the lowdown on early warning signs of electrical issues that might cause the whole system to go kaput. Local government bigwigs and bosses are in the background, showing they're really backing this program.

This hands-on learning session serves as a practical illustration of the learning by doing approach that underpins vocational education. Participants aren't just sitting around; they're hands-on, figuring out and keeping the machine's electrical system in check the instructors make sure everyone gets the hang of both the theory and the safety stuff needed when working on electricals. This matches up with the report's aim to blend scholarly insights with practical uses to boost local neighborhoods. The scene shows a team-up between the school, city officials, and people running the waste plant, all working together to keep our planet healthy for the future. In a wider sense, the photo shows how the program aims to boost the TPS3R waste facility's efficiency and dependability by constantly offering technical guidance. When operators get good at keeping electrical systems in check, they can stop machines from breaking down unexpectedly and make sure everything runs smoothly. Setting up a regular check-up schedule for equipment, backed by solid knowledge of how electric systems work, helps keep things running smoothly and saves money. Plus, the picture really nails the whole capacity-building vibe, showing how teamwork in education boosts people's skills. This moment shows off our tech advances and stands for bringing the community together for a cleaner, greener city future.

The project really brought educational institutions, local government, and community waste management groups together. Polteknepel Sumbar's role as an academic partner helped connect theory with the actual environmental issues we face. The participatory approach made sure the community wasn't just getting stuff done but was actually involved and had a say in setting up sustainable waste management. This feeling of being part of the action really pumped up the local operators to keep their gear running on their own. Plus, quite a few people from outside the TPS3R team are keen on picking up some basic machine upkeep skills, showing they're getting more aware of taking care of our planet. These results show that community service programs tackle technical issues and also strengthen social bonds. The teamwork really built a strong bond between the Polytechnic and the local government, paving the way for more teamwork down the line. By giving local people the tools they need, the program cut down on having to call in outside tech help. So, because of that, the TPS3R system in Pariaman got even better at adjusting to changes.

Even though we hit some snags along the way, we still managed to get some good outcomes. A big hurdle was the shortage of spare parts for some imported machine parts. Some belts and filters were tough to find around town, which meant repairs took longer. The project tackled this problem by making small parts in local workshops. Keeping up with the preventive maintenance schedule can be tough for operators to stick to consistently. The project crew came up with a straightforward reminder setup using printed maintenance schedules and checklists. Sometimes the weather threw a wrench in our outdoor workouts, so we had to shuffle our plans around. Budget issues also put a cap on how much we could replace parts for really banged-up equipment. Despite the challenges, both the team and the community gained some great learning experiences from them. They really stressed the importance of teaming up in the future to make local machine parts, so we can keep things going strong for the long haul.

The chat about the results reveals that mixing job training with local green initiatives leads to real, lasting benefits. Polteknepel Sumbar showed that skills from the sea can be just as useful on land, especially with their know-how in mechanical engineering. The maintenance strategies for ship engines, like oil systems, gearboxes, and maintenance focused on reliability, are super relevant for waste processing gear. This cross-disciplinary approach really boosted the Polytechnic's standing as a center for practical research and helping the community thrive. Plus, the cadets got a real kick out of their fieldwork, learning a ton by tackling actual engineering problems out in the field. These experiences really capture the heart of vocational training, blending hands-on skills with a sense of community duty. This project's success really shows how teaming up between schools and local authorities can

make a big difference in tackling environmental challenges This also lays the groundwork for upcoming initiatives that blend learning, study, and community work.

Comparing similar projects in other areas really shows how important it is to keep up with preventive maintenance Research by Santosa and colleagues in 2023 and Syahputra and team in 2020 showed that having a regular maintenance plan could make machines last 30% longer The Pariaman project showed similar success, proving that upkeep-focused actions work well The local situation called for tweaks in how we roll things out because not everyone's tech-savvy The participatory model we used gave us the freedom to adapt while still keeping up with the necessary technical requirements Participants pointed out that one-on-one guidance on the job beat traditional classroom learning This idea points to the fact that upcoming community initiatives ought to focus on hands-on, real-world methods Also, mixing handwritten logs with computerized tracking systems might boost the precision of data and keep an eye on maintenance better In general, it turns out that job focused local strategies can really make a difference on a national scale when they're tailored to the right context.

To wrap things up, this project shows that by fine-tuning the repair and upkeep of waste processing gear, we can make a real difference technically, socially, and for the planet The program did a great job cutting down on machine breakdowns, boosting the skills of the operators, and making waste management way more efficient in Pariaman City This also boosted the importance of career-focused colleges in meeting actual community demands by doing hands-on research and involving locals in the process The better state of the machines meant we had a tidier environment and fewer health hazards from unchecked trash The teamwork between the government, universities, and the community set up a repeatable blueprint for eco-friendly trash handling along the coast Challenges like running low on parts and tight budgets gave us ideas to keep getting better The program showed that little tech tweaks can lead to big green gains So, the insights from this project can act as a standard for other projects all over Indonesia In the end, it really shows how tech learning can push communities towards lasting growth.

CONCLUSION

The community service program to optimize repair and preventive maintenance of waste-processing machinery in Pariaman City demonstrated that targeted technical intervention, combined with vocational education and community engagement, substantially improves operational reliability and environmental management. Through field diagnosis, identification of critical components, hands-on operator training, and institutionally embedded maintenance schedules and SOPs, machine efficiency increased markedly and breakdown frequency declined, while operators acquired the skills to perform routine maintenance independently. Collaboration among Politeknik Pelayaran Sumatera Barat, local government, TPS3R management, and community members translated academic expertise into practical, scalable solutions, reinforcing the institution's role in applied research and Tri Dharma implementation. The initiative also fostered community ownership, enhanced awareness of waste segregation and recycling, and strengthened interinstitutional links that support long-term sustainability. Documented outputs—training modules, technical records, and procedures—facilitate monitoring, evaluation, and replication in other coastal cities facing similar challenges. For further improvement and scale-up, integrating digital monitoring and IoT-assisted maintenance is recommended to enhance data accuracy and predictive upkeep. Overall, the project demonstrates that combining preventive and corrective maintenance with capacity building and institutional collaboration yields measurable gains in equipment performance, human capital, and environmental outcomes, offering a replicable model for sustainable urban waste management aligned with national development and SDG objectives.

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AUTHOR CONTRIBUTION STATEMENT

BR conceived and led the community service project and coordinated institutional partnerships; IK managed field operations and stakeholder engagement with TPS3R and local government. RP conducted technical diagnostics, identified critical components, and supervised repair works; AW designed and delivered operator training and SOP implementation. HD oversaw data collection, monitoring, and documentation; AA performed data analysis, synthesized results, and drafted the manuscript. All authors reviewed, revised, and approved the final manuscript.

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