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Supporting SDGs Through Efficient Technology by Implementing PDCA and Renewable Energy at PT. Dharma Electrindo

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ARTICLE INFO

Paper Type:
Research Paper

Keywords:
Energy Efficiency; Manufacturing; SDGs; renewable energy technology; energy technology

Article History
Received: 22 August 2024
Revised: 29 November 2024
Accepted: 6 December 2024
Available online: 11 December 2024

ABSTRACT

The SDGs, launched by the UN in 2015, replaced the MDGs with 17 goals, focused on eliminating poverty, environmental protection, and global prosperity. PT. Dharma Electrindo Manufacturing adopts environmentally friendly technology to save energy and reduce emissions, supporting SDGs. Without the SDGs, there is a need for innovation in manufacturing technology to support SDGs 8, 12, and 13. This study will improve the sustainability of the industry. This research analyzes the effectiveness of energy and environmental improvements at PT. DEM in supporting SDGs. This research design uses a descriptive qualitative approach with a Plan-Do-Check-Action cycle to improve energy efficiency and reduce emissions at PT. Dharma Electrindo MFG, with data collected through questionnaires, checklists, and monitoring. Studies show the SDGs are effective for some goals, but cost and weather dependency hinder the efficiency of innovative technologies. The application of efficient technology and PDCA methodology at PT. DEM improves energy and environmental management, reduces emissions by 12% per year, and increases operational efficiency. The implementation of LED lights, automatic watering systems, and renewable energy technology supports SDGs by reducing electricity consumption by 21,790.12 kWh. Theory and practice show PDCA technology supports energy efficiency and the SDGs.

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Cite this article as: Sukarsono, A., Irawan, PA., Pradana, JA. (2024). Supporting SDGs Through Efficient Technology by Implementing PDCA and Renewable Energy at PT. Dharma Electrino. *Airlangga Journal of Innovation Management, 5(4), 753-771.* https://doi.org/ 10.20473/ajim.v5i4.62198

Introduction

The Sustainable Development Goals (SDGs) is an agenda of the United Nations (UN) which was launched on September 25, 2015, to end poverty, protect the planet Earth, and ensure prosperity for all humankind (Mustafa et al., 2024; Opazo-Basáez et al., 2024; Pradana et al., 2024; Wickberg et al., 2024). The SDGs replace the Millennium Development Goals (MDGs) and are valid from 2015 to 2030, consisting of 17 goals and 169 targets (LD Indrasari et al., 2021). As part of Indonesia's commitment to achieving these goals, Presidential Regulation Number 59 of 2017 concerning the Implementation of the Achievement of Sustainable Development Goals was issued (Elzein, 2024; Fauzin et al., 2024; Garcia-Saravia Ortiz-de-Montellano et al., 2023; Hsieh et al., 2023). This concept aims to create harmony in development without destroying the environment, which functions as an ecosystem for the continuity of future generations, especially in the manufacturing industry sector (Awal & Chowdhury, 2024; Hauashdh et al., 2024; Koamri et al., 2022; Obaideen et al., 2022). Manufacturing, as the main driver of wealth and societal wealth and welfare (Alami et al., 2023; Indrasari et al., 2024; Suárez Giri & Sánchez Chaparro, 2023; Zhu et al., 2024), is facing global challenges in achieving sustainable production due to resource depletion and environmental degradation (Adebayo et al., 2022; Chen et al., 2023; Liu et al., 2022; Nowak et al., 2024; Oladapo, 2024; Zhao et al., 2024).

This demands innovative production methods that reduce environmental impact. In response, manufacturing companies, including PT. Dharma Electrindo Manufacturing, which was founded in 2002 and produces wiring harnesses and electrical components for automotive, is starting to adopt an environmentally friendly approach (Qasem et al., 2024). Considering the large energy needs and high electricity consumption in company work areas, it is important to implement energy-saving strategies that align with SDGs and company policies to support sustainable economic growth. The use of lights during morning shifts lacks sufficient energy efficiency because the lights may be on for longer than necessary or use types of lights that are not energy efficient (Anuardo et al., 2023; Iqbal et al., 2023; Lai et al., 2023). Currently, conventional lamps have not been replaced with energy-saving LED lamps and there is no employee education about the importance of turning off lights when not in use. This action cannot be implemented in less than 1-3 months.

Additionally, watering costs are not managed efficiently due to the absence of an automatic watering system (Yao et al., 2023)(Ghifara et al., 2022). Without soil sensor technology to monitor moisture levels and adjust watering schedules, cost savings cannot be achieved (Bonello et al., 2024; Oladapo, 2024; Zhao et al., 2024). These changes cannot be implemented in less than 2-4 months. Furthermore, leaks in chuck seal hoses are not adequately addressed due to a lack of regular inspections, operator training, and selection of more durable hose materials. Without these steps, material waste and machine damage are inevitable. Addressing these issues would take 1-2 months. Emissions that exceed 12% per year are not reduced without implementing clean technologies, improving ventilation and air filtration systems, and employee training. Investments in renewable energy sources and increasing energy efficiency in production machines cannot be done in less than 3-6 months (Qosim et al., 2023).

Existing studies suggest that Industrial Solution Services (ISS) are most effective at encouraging innovation without an SDG framework. However, within the SDG framework, Operational and Green ISS become more significant in driving innovation (Riduwan & Wardhana, 2022), supported by the advancement of Additive Manufacturing (AM) technology, offering innovative and environmentally friendly solutions in the aerospace and automotive industries (Alami et al., 2023; Opazo-Basáez et al., 2024). The photovoltaic (PV) system is considered the best alternative for renewable energy, with a circular economy model addressing sustainability and SDGs-related issues in production and environmental pathways. Its dominant effectiveness is seen in SDGs 8, 12, and 13, and less so in SDGs 4, 5, 10, and 16

(Garcia-Saravia Ortiz-de-Montellano et al., 2023; Nowak et al., 2024; Rabaia et al., 2024; Wickberg et al., 2024; Zheng & Wang, 2012). The study of SDG Certification complements environmental management systems, provides a more comprehensive perspective, and improves sustainability strategies and practices (Mosgaard & Kristensen, 2023). Minimizing large waste requires effective management to reduce environmental impacts and support SDG 12 (Khairul Akter et al., 2022)(Wardhana, 2023). Minimizing large-scale waste is essential, waste can be innovatively transformed into renewable energy products, which is crucial for reducing pollution and climate change, with challenges such as high costs and weather dependence that support 11 of the 17 SDGs, including the availability of water, health and clean energy in balance with demand and supply (Ferrad & Cristina, 2024; Obaideen et al., 2022; Trinh & Chung, 2023; Zhu et al., 2024). Achieving this balance requires a solid risk mitigation process to find the root of the problem of failure to implement the SDGs (Indrasari et al., 2024; Modi et al., 2024; Wibowo & Ahyudanari, 2021).

One of the implementations is the Plan-Do-Check-Action (PDCA) (Setiawan & Supriyadi, 2021). PDCA studies can reduce human errors, and increase machine efficiency and product quality in the manufacturing industry (Ahmad Taufik, 2020)(Pratiwi et al., 2022). The study shows that although the SDG framework can strengthen the impact of innovation in industrial services with environmentally friendly technologies, there are several significant weaknesses. First, the application of the circular economy model shows dominant effectiveness on SDGs 8, 12, and 13 (Wardhana, 2022)(Zakik et al., 2022). However, it shows less impact on SDGs 4, 5, 10, and 16, highlighting inequality in goal achievement. Second, although photovoltaic systems and additive manufacturing technologies offer innovative solutions, challenges such as high costs and dependence on weather hinder the efficiency and implementation of some SDGs.

This study will be conducted in line with the perspective of SDGs using the PDCA approach. This decision is based on findings that can improve the sustainability of the manufacturing industry (Fois & Cocco, 2022), has proven real implementation in the European region (Glavic et al., 2023), and its ability to reduce product defects by up to 65.61% (Adriantantri et al., 2023). PDCA approach studies enhance inclusive design and efficiency, supporting social sustainability with the challenge of organizational culture transformation (Antonelli et al., 2024). This study can support the achievement of SDGs in dairy factory design, increasing the sustainability of food production (Fois & Cocco, 2022). PDCA approach has demonstrated the ability to increase production output by 12% through improvements in machines, methods, and materials (Arfan et al., 2023). Furthermore, this study supports advancements in technologies aimed at reducing emissions, adopting hydrogen as a clean energy source, and aligning with the European Green Deal and SDGs (Glavic et al., 2023).

This study has a purpose to observe effectiveness of energy system improvements and environmental management at PT. DEM in supporting the achievement of the SDGs through the application of systematic technologies and methodologies. The theoretical contributions include insights into the integration of PDCA technology and methods in energy and environmental management and their impact on achieving the SDGs. Practically, this research provides concrete recommendations for increasing energy efficiency, reducing emissions, and optimizing system maintenance, thus supporting operational sustainability and compliance with the SDGs.

Literature Review

Plan-Do-Check-Action (PDCA) is a highly effective method for driving innovation, particularly in efforts to achieve the Sustainable Development Goals (SDGs) (Ahmad Taufik, 2020; Firza Faturahman & Ferdian, 2022; Isniah et al., 2020). Within the SDG framework, operational innovation and the application of environmentally friendly technology play a crucial role in achieving better outcomes. One example is Additive Manufacturing (AM) technology, which offers innovative and eco-friendly solutions for the aerospace and automotive industries (Alrbaey et al., 2016; Gottschalk et al., 2023). On the other hand, photovoltaic (PV) systems have become a leading alternative in renewable energy, aligned with the circular economy model to address sustainability challenges (Gönül et al., 2022). This model has proven effective in achieving SDGs, particularly in terms of decent work, responsible consumption and production, and climate action.

The importance of effective waste management is a key focus in supporting SDG 12. Waste processed into renewable energy products can reduce pollution and the impacts of climate change (Mafruchati et al., 2022). However, challenges such as high costs and weather dependency must still be overcome to achieve a balance between the demand and supply of clean energy (Chen et al., 2023)(Wardhana et al., n.d.). This balance is crucial as part of the risk mitigation process, particularly in identifying the root causes that may hinder SDG implementation. One method that has proven effective in this regard is the application of PDCA. The PDCA approach not only reduces human errors but also enhances machine efficiency and product quality in the manufacturing industry (Solaymani & Montes, 2024; Trinh & Chung, 2023)(Santoso & Kusuma, 2023). Thus, PDCA becomes an essential tool for achieving sustainable innovation and supporting the broader achievement of the SDGs.

Methodology

This research design uses a descriptive qualitative approach by applying the Plan-Do-Check-Action cycle to evaluate and improve energy efficiency (Pramono et al., 2023). Not only that, the cost of watering, engine maintenance, and emission reduction(Ahmad Taufik, 2020; Firza Faturahman & Ferdian, 2022; Isniah et al., 2020). At the Plan stage, problem identification is carried out through observation documentation and fishbone diagrams, followed by a repair plan.(Adriantantri et al., 2023; Fatma et al., 2020; Setiawan & Supriyadi, 2021). The Do stage includes the implementation of the plan.(Ahmad Taufik, 2020; Arfan et al., 2023). At the Check stage to carry out energy efficiency and emission reduction(Adebayo et al., 2022; Amar et al., 2024; Glavič et al., 2023; Mustafa et al., 2024). Finally, the Action stage involves the implementation of successful results, in the overall operational sustainability of PT. DHARMA ELECTRINDO MFG(Hauashdh et al., 2024; Liu et al., 2022; Trinh & Chung, 2023; Zehra et al., 2024).

Research instruments include questionnaires and surveys to assess employee understanding and satisfaction surveys and changes in production processes.(Arfan et al., 2023; Debnath et al., 2024; Suárez Giri & Sánchez Chaparro, 2023). Inspection checklists are used to record the condition of facilities in the production area.(Fois & Cocco, 2022; Suárez Giri & Sánchez Chaparro, 2023; Zheng & Wang, 2012). Data logging and monitoring include recording energy usage and measuring emission levels to monitor reductions and compliance with environmental standards (Di Stefano et al., 2024; Hsu, 2023; Jin et al., 2023). The evaluation report documents the results of routine inspections, water usage, and corrective actions, while direct observations are conducted to identify bottlenecks in the production process (Glavič et al., 2023; Indrasari et al., 2024; Liu et al., 2022; Pramono et al., 2023).

The research procedure was carried out with the following steps: first, collecting observation data related to the use of morning shift lights, watering costs, chuck seal hose leaks on auto engines, and annual emissions in the checklist model.(Antonelli et al., 2024; Fatma et al., 2020; Mustafa et al., 2024). Next,

analyze the data using a fishbone diagram to identify the root cause of the problem and determine an improvement plan (Isniah et al., 2020; Setiawan & Supriyadi, 2021). After the implementation of the plan, evaluation is conducted by measuring training participation, frequency of machine inspections, use of LED lights, and energy efficiency through attendance lists, inspection reports, and productivity data. Implementation is carried out by implementing steps that can increase operational efficiency and sustainability (Wijayanti et al., 2020)(Ryandono et al., 2020). The collected data is then analyzed to evaluate the effectiveness of improvements and identify the need for further corrective action.

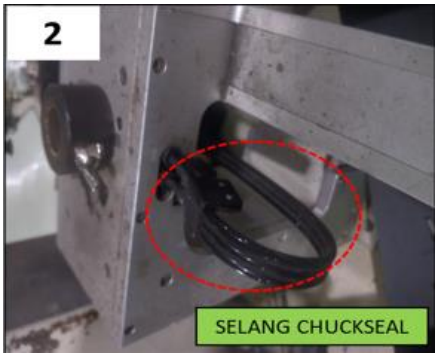
Results and Discussion

Results.

1. Observation Document

(a) Use of Morning Shift Lights

(b) Watering Costs



(c) Chuckseal Hose Leaks on Auto Engines

(d) Emissions above 12% per year

Figure 1. Observation Documentation

Source: Observation Data, 2023

These observations note that the use of lights during the morning shift requires improvements in terms of energy efficiency. Currently, lights may be on for longer than necessary or use types of lights that are not energy efficient (Table 1 Figure a). To increase efficiency, PT. DEM may consider several actions, such as replacing conventional lamps with energy-saving LED lamps equipped with automatic sensors to adjust light intensity based on ambient light conditions. Additionally, educating employees about the importance of turning off lights when they are not needed can help reduce energy consumption.

Watering costs can be a problem if not managed efficiently, especially if the facility has many green areas that require regular maintenance. Using automatic watering systems tailored to specific plant and weather needs can reduce water use and associated costs. Implementing soil sensor technology to monitor

humidity and activate the watering system only when needed is an innovative step that can be taken. Additionally, using plants that tolerate drought and do not require frequent watering can help reduce costs (Table 1 Figure b).

Leaks in the auto engine chuckseal hose indicate a maintenance problem that needs to be addressed immediately. This leak can cause a waste of materials and time and has the potential to cause further damage to the machine. Solutions that can be implemented include regular inspections to detect leaks early, training for operators regarding proper equipment handling and maintenance, and selecting materials that are more durable and suitable for specific operational conditions (Table 1 Figure c).

Emissions above 12% per year indicate serious problems in environmental management that must be corrected immediately (Zulaikha et al., n.d.)(Juliansyah et al., 2021). High emission levels harm the environment and violate government regulations and industry standards (Wardhana & Ratnasari, 2022). To overcome this, PT. DEM can evaluate and optimize production processes to make them more environmentally friendly. Steps that can be taken include using clean technology, improving ventilation and air filtration systems, and training employees on best practices in reducing emissions. Investments in renewable energy sources and improving energy efficiency in production machines can also help reduce emissions significantly (Table 1 Figure d). By identifying and planning improvements in these areas, PT. DEM can strengthen its position as an automotive company committed to efficiency and sustainability, and contribute positively to achieving the Sustainable Development Goals (SDGs).

2. *Plans*

The fishbone diagram presented identifies various root causes that hinder the implementation of Sustainable Development Goals (SDGs). In the Machine category, problems such as chuckseal hose leaks are detected, machine inspections are carried out only once every four months, and neglect of minor damage, all of which can trigger production losses and increase maintenance costs (Figure 1).

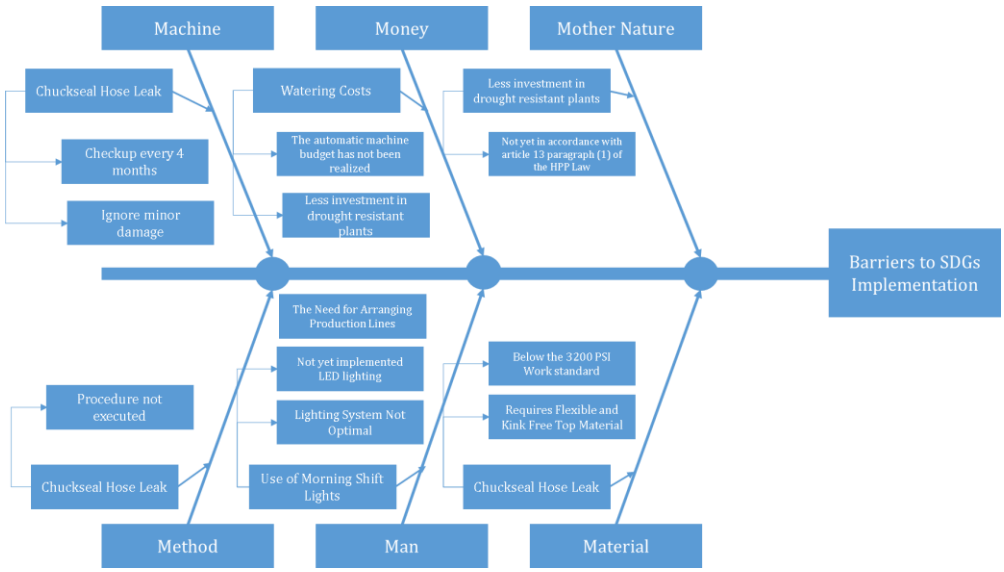


Figure 1. Fishbone Diagrams

Source: Author (2023)

On the ***Money*** side, constraints include high storage costs, unrealized budgets for automated machinery, and lack of investment in drought-resistant crops, which limits adaptation to climate change.

Mother Nature (Nature) category, environmental problems such as annual emissions exceeding 12% and non-compliance with environmental legal regulations-specifically following article 13 paragraph (1) of the HPP Law, which harms the environment and public health. The Method category highlights non-compliance with standard procedures and inadequate handling of chuckseal hose leaks, indicating the need for evaluation and procedural improvements. For Man ***(Human),*** challenges include the need to reorganize production lines for greater efficiency, implement LED lighting to reduce costs and emissions, and optimize lighting systems to enhance productivity. Finally, in the ***Materials*** category, quality problems such as materials that fail to meet the 2300 PSI Work standard and the use of inflexible, kink-prone materials cause product failures and production problems. This analysis highlights areas that require corrective action to address these obstacles and support progress toward achieving the SDGs. PDCA studies contribute to addressing human, machine, material, and methodological factors through the use of fishbone diagrams (Adriantantri et al., 2023).

To address these obstacles, several proposed improvements can be implemented. First, in the ***Machine*** category, it is necessary to increase the frequency of routine inspections on machines, such as scheduling monthly checks, which can help detect and resolve damages early. Additionally, implementing a preventive maintenance program can mitigate frequent chuckseal hose leakage problems. In the ***Money*** category, prioritizing the allocation of funds for investments in automated machinery and drought-resistant crops can improve efficiency and adaptability to climate change (Febriyanti et al., 2022). Furthermore, reviewing storage costs and looking for alternative solutions to reduce them can free up budgetary resources for other SDG-supporting activities.

For ***Mother Nature***, emission reduction measures, such as adopting environmentally friendly technologies and ensuring compliance with environmental legal regulations are crucial. These sustainable strategies can help minimize environmental impacts. In the ***Method*** category, training and socialization on Standard Operating Procedures (SOPs) are necessary to ensure employees understand and apply the procedures correctly (Mendo et al., 2023). Implementing a quality management system can also improve the identification and resolution of hose leaks.

Regarding ***Man***, setting up a more efficient production workflow using workflow analysis can help identify and eliminate bottlenecks. The implementation and optimization of LED lighting systems must be prioritized to reduce energy consumption and operational costs. Finally, in the ***Materials*** category, ensuring that material quality meets standards, such as the 2300 PSI Work benchmark, can minimize the risk of product failure. Choosing flexible, kink-free materials for hoses will also increase reliability in production processes. By adopting these proposed improvements, companies can effectively overcome challenges, achieve SDG goals, and enhance the sustainability of their operations.

3. *Do*

Implementation of planned improvement plans. The first step is to conduct training and outreach to increase employee understanding of standard operating procedures (SOP) and the importance of implementing improvements. Regular training sessions are held for all employees, equipped with easily accessible training materials and SOP guides. In addition, preventive maintenance is implemented by arranging a monthly inspection schedule for all machines and carrying out routine checks and minor repairs before problems develop into bigger ones. Investments in environmentally friendly technology are also implemented by replacing conventional lights with LED lights throughout the facility and introducing new, more efficient technology, such as automated production systems. More effective budget management is implemented by reviewing budget allocations for automatic machines and drought-resistant plants and researching alternative, more economical storage solutions (Mafruchati et al., 2023). Finally, production

path optimization is carried out to increase efficiency and reduce bottlenecks in the production process (Muhaimin et al., 2023). By implementing these activities, the company can more effectively achieve improvement goals and increase operational sustainability at PT. DEM.

4. *Check*

In the "Check" stage at PT. Dharma Electrindo, evaluation of the implementation of improvements at the "Do" stage was carried out thoroughly. First, employee participation in training and socialization of the new SOP is examined, with success criteria in the form of 100% participation and more than 80% of employees passing the evaluation test measured through attendance lists and written tests (Table 2).

Table 2. Check

Aspect	Checking Activities	Success Criteria	Evaluation Method
Training and Socialization	Check employee participation in training sessions.	100% of employees take part in training.	Register for training attendance.
	Assess employee understanding of new SOPs.	>80% of employees passed the SOP evaluation test.	Written exam or online quiz.
Implementation of Preventive Maintenance	Evaluate the frequency and results of machine inspections.	50% reduction in machine breakdown incidents.	Inspection reports and maintenance records.
	Check routine maintenance records.	Increase in machine uptime.	Operational data analysis.
Investment in Technology	Monitor the use and efficiency of LED lights.	Reduction of energy consumption by 20%.	Energy usage report.
Environmentally friendly	Review the application of automated production technology.	Increased production efficiency by 15%.	Data on productivity and production output.
Budget Management	Analyze changes in budget allocations.	Budget realization according to planning.	Monthly financial reports.
	Assess the efficiency of new storage solutions.	Reduction of storage costs by 10%.	Storage cost analysis.
Production Line Optimization	Examine production workflows and identify remaining bottlenecks.	Reduction of production cycle time by 15%.	Direct observation and cycle time analysis.
	Evaluate employee satisfaction with changes in production trajectory.	Increased employee satisfaction scores in internal surveys.	Employee satisfaction survey.

Source: Observation, 2023

Furthermore, the frequency and results of machine inspections are evaluated to ensure a 50% reduction in machine breakdown incidents, with analysis carried out through inspection reports and maintenance records. The implementation of LED lighting and automated production technology was monitored to measure a 20% reduction in energy consumption and a 15% increase in production efficiency, through energy usage reports and productivity data. Budget management is evaluated with a focus on budget realization according to planning and the efficiency of the new storage solution as measured through cost analysis. Finally, production trajectory optimization was examined by identifying bottlenecks ensuring a 15% reduction in production cycle time, and measuring employee satisfaction through internal surveys. This evaluation aims to ensure that the implementation of improvements could achieve the target and determine corrective steps for the future.

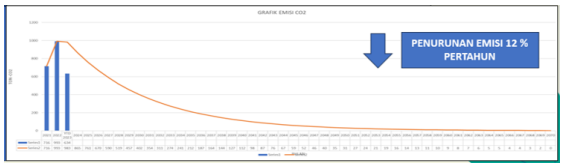
Discussion

Actions taken by PT. Dharma Electrindo Manufacturing (PT. DEM) as part of their efforts to achieve the Sustainable Development Goals (SDGs) in the automotive sector. To minimize the use of light energy, PT. DEM has successfully implemented the Sky Light lighting system, which allows optimal use of natural light, thereby reducing dependence on artificial lighting (Figure 3).

(a) Implementation of Sky Light to Minimize Light Energy

(b) Watering using Certified Waste Water Minister of Environment Regulation No. 6 of 2021

(c) Reduce Electricity Use with Chuckseal Hose and Hose Repairs



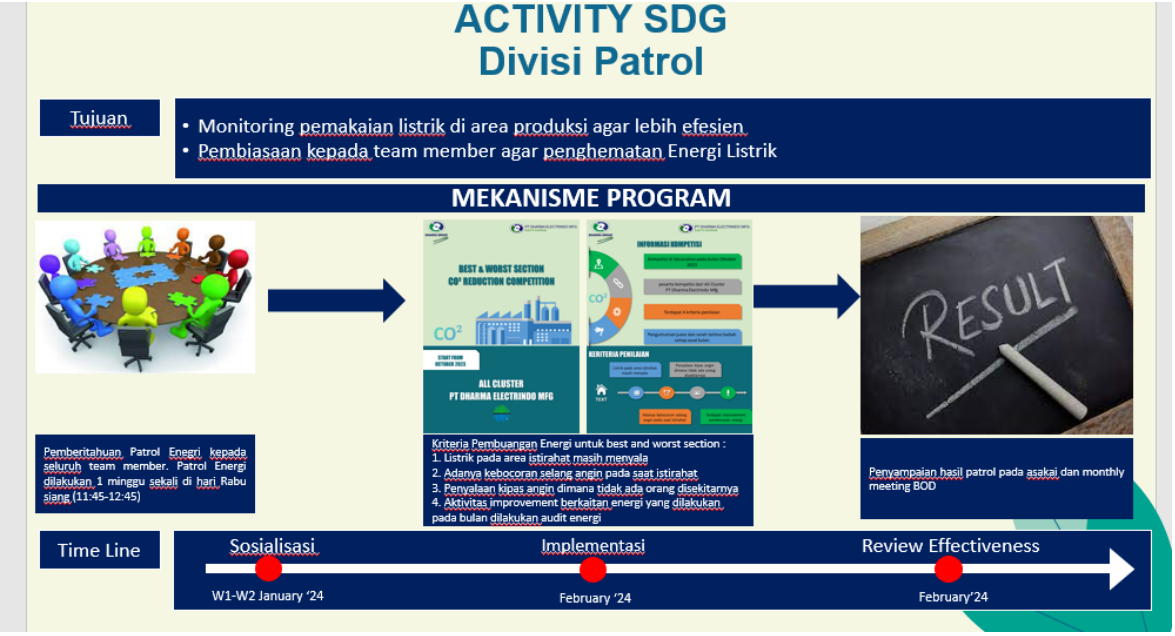
(d) Emissions decreased 12% per year

Figure 3. Post-Implementation Action of SDGs

Source: Implementation, 2024

In addition, the company has implemented a watering system using certified wastewater following Minister of the Environment Regulation No. 6 of 2021, which not only saves the use of clean water but also supports the principles of recycling and sustainability. Through improvements to the hose and hose chuckseal, the company could reduce electricity usage. The impact of this action is clearly visible with a reduction in emissions of 12% per year, showing PT's commitment. DEM reduces environmental impacts and increases operational efficiency. The implementation of these various initiatives is the result of a

planned and systematic action approach, demonstrating the company's dedication to implementing more sustainable and responsible industrial practices.



Picture 4. Patrol Division SDG Activities

Source: Author (2023)

PT. Dharma Electrindo Manufacturing (PT. DEM), which operates in the automotive sector, implements a program for monitoring and saving electrical energy as part of efforts to achieve the Sustainable Development Goals (SDGs) using the action research method (figure 2). This program aims to monitor electricity use in production areas to make it more efficient and familiarize team members with saving energy. The program mechanism involves outreach to the patrol team regarding energy savings, implementation of monitoring and evaluation of energy saving criteria, as well as reviewing the effectiveness of the results through monthly meetings. The program stages take place from January to February 2024, starting with socialization, followed by implementation, and ending with a review of the results. This program supports the achievement of SDG 7 (Clean and Affordable Energy) by increasing energy efficiency and reducing carbon emissions, as well as integrating environmental awareness in factory operations. Thus, PT. DEM is committed to optimizing energy use and contributing to environmental sustainability in the automotive industry.

Picture 5. SDG Activity Technical Division

Source: Author (2024)

PT. Dharma Electrindo Manufacturing (PT. DEM), which operates in the automotive sector, carries out activities to achieve the Sustainable Development Goals (SDGs) using the action research method (Figure 3). This program includes replacing some electricity sources with energy-efficient facilities, meeting customer requirements to reduce CO2 emissions, and meeting PROPER GOLD criteria for reducing energy consumption. This implementation involves the use of technology such as LED lights with light and motion sensors, as well as energy-saving toilet lights, which are installed in various locations to optimize energy consumption.

The program mechanism includes the proposal and approval stages, trials, implementation, and effectiveness review which will take place from September to November 2024. PDCA also has the impact of optimizing tolerance limits, due to human, material, and machine factors(Fatma et al., 2020). This program can increase energy efficiency and operational sustainability and reduces the environmental impact of automotive factory activities, in line with SDG 7 (Clean and Affordable Energy) and SDG 13 (Tackling Climate Change). Thus, PT. DEM demonstrates a commitment to innovation and environmental responsibility in its operations.

Picture 6. Technical Factor Summary

Source: Author (2024)

PT. Dharma Electrindo Manufacturing (PT. DEM) demonstrated the implementation of a renewable energy system in the factory through the installation of solar panels (solar PV). It shows the capacity of solar panels in various configurations: off-grid for public facilities, hybrid in factories, and off-grid in factories (Figure 4). PDCA studies have been on the cusp of being effective for continuous improvement in the service and manufacturing sectors, increasing productivity(Firza Faturahman & Ferdian, 2022; Isniah et al., 2020). System capacity includes solar panels with capacities ranging from 292.3 kWp to 2,307 kWp, inverters, and batteries to store energy. This application is part of the action research method in industrial engineering, where PT. DEM is actively seeking practical solutions to increase energy efficiency and reduce the carbon footprint, in line with SDG 7 (Clean and Affordable Energy) and SDG 13 (Tackling Climate Change). This implementation could contribute to the sustainability of automotive factory operations through technological innovation and saving energy costs.

Conclusion

This research shows that the application of efficient technology and PDCA methodology at PT. DEM has succeeded in improving energy and environmental management, reducing emissions, and increasing operational efficiency. The implementation of LED lights, automatic watering systems, and renewable energy technology shows a positive impact on achieving the SDGs, especially on energy efficiency and reducing environmental impacts. Sustainable development goals are the obligation of all companies to develop technology that is in line with global sustainable development goals, namely economic, social, and environmental, which are realized in the form of action plans for people, the earth, prosperity, and world peace. The sustainable development goal activities carried out by PT. Dharma Electrindo Manufacturing has been adjusted to the Zero Emission (0 Emissions) policy in 2070 with an annual reduction in emissions of 12%. In line with this, the total emissions saved by reducing electricity consumption is 21,790.12 KwH.

These findings imply that automotive companies can significantly improve the sustainability of their operations by adopting environmentally friendly technologies and structured quality management systems.

In addition, efficient energy management practices and proactive system maintenance can support the achievement of sustainable development goals and improve a company's reputation in the global market.

Future research could focus on long-term evaluation of the impact of green technologies and PDCA methods on the environmental and operational performance of companies in the automotive sector. Research could also explore the latest innovations in renewable energy technologies and intelligent maintenance systems, as well as other methodological applications that can strengthen the achievement of the SDGs in different industrial contexts.

Author's Contribution

Putut Ade Irawan and Johan Alfian Pradana: Conceptualization, Methodology, Supervision, Validation and Software.
Putut Ade Irawan.: Data curation, Reviewing and Editing, Writing- Original draft preparation.
Johan Alfian Pradana: Visualization, Investigation, and Writing- Original draft preparation

Acknowledgments

We express our deep gratitude to the Master of Industrial Engineering, Faculty of Industrial Technology, Adhi Tama Institute of Technology Surabaya, and Industrial Engineering, STT POMOSDA Nganjuk, for their support and valuable contributions in completing this research. Assistance and cooperation from these two institutions were instrumental in the success and smoothness of the research process.

Declaration of Competing Interest

The authors declare that they have no competing interests

Fundings

This article did not receive any funding

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