# Informal Education Development Through Capacity Building With Emphasis on Environmental and Sustainability Behaviour: Case of Pindad Defense Industry Manufacturing, Indonesia

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## Abstract

Indonesia is one of the developing countries that focuses on manufacturing industry activities, such as Pindad which is a national defense and security product manufacturing industry. This paper discusses the relationship between informal education through capacity building with the concept of environmental management and sustainability, by conducting Group Interactive Workshop and Periodical Discussion. The fact that there is regeneration age gap, this paper discussed the importance of development of human resources (SDGs 4), especially millennials who are the driving force in managing environmental impact from manufacturing activities. Therefore, it has considered urgent to accelerate the knowledge improvement for better environmental performances. The results shows that more than 40 millennials with an approximately gender balance of 50:50 (SDGs 5) have participated in capacity building activities in the field of integrated environmental management knowledge of production activities consisting of several production divisions (SDGs 9), including the Special Vehicle Division, Weapons Division, Heavy Equipment Division, and Infrastructure and Service Infrastructure Division. From this activity, innovations were produced in related fields with emission reduction results of 16.9 tons of $CO_2$-eq (SDGs 13), reduction in wastewater load of 0.0014 tons of TSS (SDGs 14), 3R of Solid Waste of 215 tons of scrap (SDGs 12), and 3R of Hazardous Waste of 0.64 tons of paint dust (SDGs 12). This paper also discussed the contribution of the authors as leaders (SDGs 17) in each environmental stream plays a key role in maintaining the knowledge update to each production division, aligning with sustainability.

*Keywords:* defense industry, capacity building, sustainable development goals

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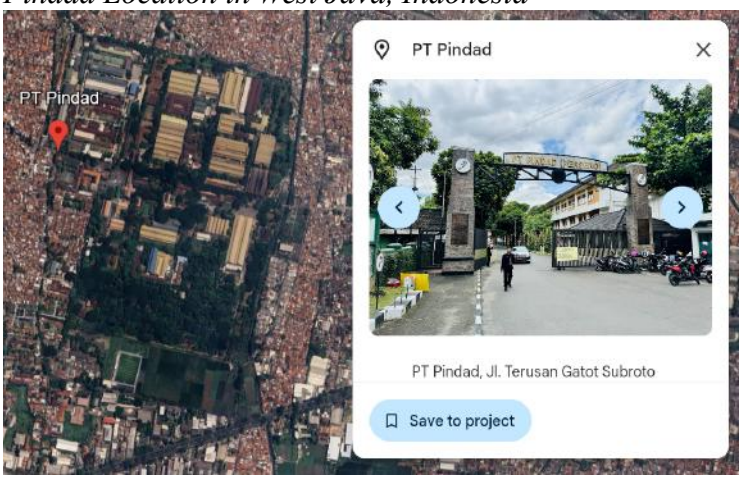
## Introduction

PT Pindad is a strategic state-owned enterprise in Indonesia engaged in manufacturing defence and commercial products (Pindad, 2025). With facilities located in West and East Java, the company serves as a vital arm of Indonesia's defence industry (see Figure 1). However, in response to increasing global concern over environmental degradation and climate change, Pindad recognized the urgent need to embed sustainability principles into its operational culture.

**Figure 1**
*Pindad Location in West Java, Indonesia*




This initiative takes a progressive stance by targeting millennials—a demographic that constitutes a significant portion of Pindad's workforce. It addresses generational gaps in environmental literacy and utilizes informal education as a tool for empowering workers. The informal approach allows for a more adaptive, collaborative, and interactive environment for learning, breaking away from rigid formal training structures.

This study evaluates the impact of such an initiative on environmental performance and workforce engagement by emphasizing the synergy between environmental innovation and human capital development aligned with the United Nations Sustainable Development Goals (UN SDGs).

## Literature Review

Capacity building and informal education have been increasingly recognized as effective strategies for advancing sustainability, especially in industrial sectors (Gunningham et al., 2003). According to UNESCO (2018), informal education can complement formal training by leveraging peer learning, experiential activities, and on-the-job exposure. Within corporate settings, this often manifests in knowledge-sharing workshops, periodical discussions, innovation hubs, and community-of-practice models.

In the defence industry, environmental performance has traditionally taken a backseat to operational efficiency and national security concerns (Permatasari et al., 2022). However, studies by the International Journal of Environmental Research (2020) note that sustainability practices, when institutionalized, do not hinder productivity but rather promote innovation and cost savings.

Moreover, the intergenerational dynamics of workforce transformation—particularly engaging millennials—have emerged as a crucial aspect of organizational learning. Millennials tend to be more environmentally conscious and technologically adept, making them ideal agents of change in industries seeking sustainable transition (PwC, 2021).

## Methods

This study uses a combined-methodological approach using quantitative environmental metrics and qualitative assessments of employee participation and innovation outcomes. Key components of the program included:

- **Interactive Workshops**: Held monthly, involving case studies, role-playing, and problem-solving tasks related to environmental scenarios.
- **Thematic Discussions**: Conducted weekly and biweekly, focusing on specific sustainability topics such as emission control, energy audits, and waste segregation.
- **Division-based Projects**: Participants were grouped according to their operational divisions and tasked with proposing and implementing at least one green innovation.

Data collection tools included attendance records, innovation logs, internal audit reports, pre- and post-activity surveys, and interviews with environmental coordinators. Impact was measured over a 12-month period (2024–2025).

## Results and Discussion

The results of the program are categorized into three main impact areas: environmental performance, employee capacity, and organizational innovation.

### Environmental Performance

- **Energy Efficiency**: A comprehensive energy audit led to the identification of inefficient equipment and improved scheduling of machine operations. This saved 7,843 GJ of energy and approximately $15,500 in electricity costs. (see Figure 2)

**Figure 2**

*Operational Activities Embedded With Energy Efficiency Program*

*Source.* Herliani et al. (2024)

- **Emission Reduction**: Process innovations reduced carbon emissions by 16.9 tons of CO2-equivalent. (see Figure 3)

**Figure 3**

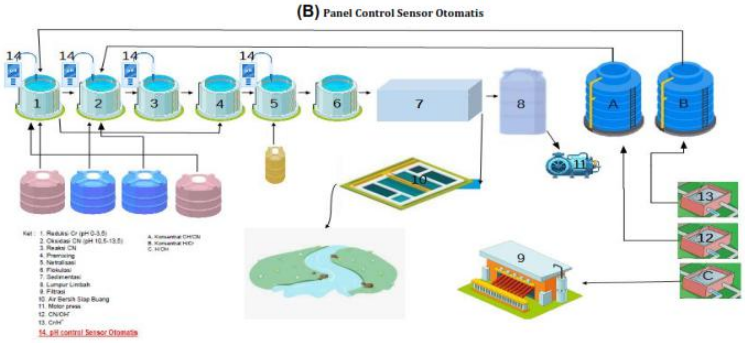
*Cleaner Production Based Emission Reduction Program Developed by Pindad*

*Source.* Ritaudin et al. (2024)

- **Water Management**: Installation of an RO-based water recycling system allowed 60% of wastewater from testing units to be reused. This resulted in a decrease of 0.0014 tons of TSS. (see Figure 4)

**Figure 4**

*Reverse Osmosis Innovation Technology for Wastewater Treatment*




*Source:* Arafat et al. (2024)

- **Solid Waste**: A 3R approach applied across four production units processed 215 tons of metal scrap for reuse and recycling. (see Figure 5)

**Figure 5**

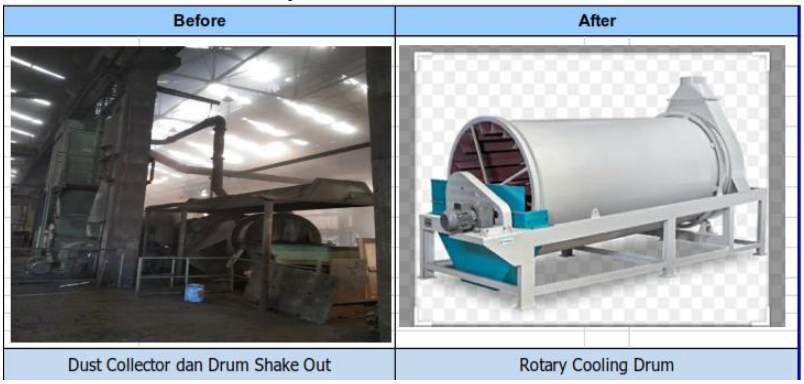
*Metal Scrap Utilization for Product Optimization*

*Source.* Permadi et al. (2024)

- **Hazardous Waste**: Development of localized paint-dust collectors minimized 0.64 tons of hazardous waste from painting booth process. (see Figure 6)

**Figure 6**

*Paint-Dust Collectors for Hazardous Waste Minimization*



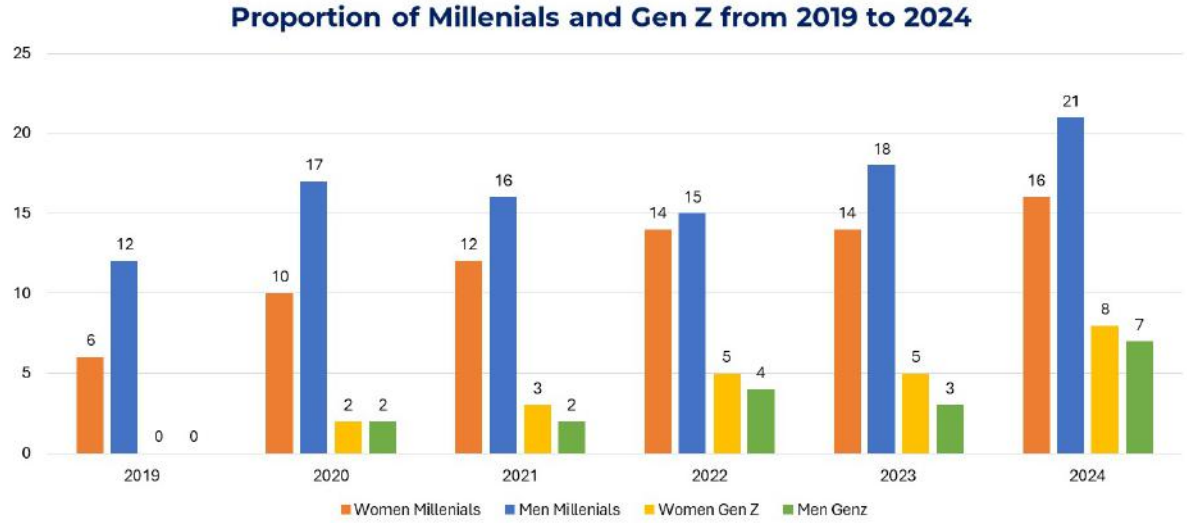

*Source.* Dewantara et al. (2024)

## Human Capital Development

Participation rates remained above 85-90% across all events. Informal education improved baseline knowledge scores by 50-80% (measured through pre-and post-activity quizzes). Feedback indicated strong interest in practical, hands-on learning methods. Importantly, millennial participants expressed increased motivation and ownership of environmental goals, identifying strongly with company values and SDG alignment. As this paper focusing on the activities and the proportion of youth generation, here is the proportion of each champion participants as depicted in Figure 7.

**Figure 7**

*Proportion of Millennials and Gen-Z Involvement in Capacity Building Activities*




*Source.* Roshaliha et al. (2025)

The graph illustrates a notable rise in the participation of millennials and Gen Z individuals over the period from 2019 to 2024. The data also reveals a balanced growth in participation between female and male employees, underscoring Pindad's commitment to sustainability and equality in its capacity-building initiatives. Going forward, we expect this initiative to be

implemented optimally, yielding meaningful benefits for the younger generation in the manufacturing sector.

**Innovation and Knowledge Sharing**

Here are several new internal innovations were submitted for intellectual property protection, including:

- Portable of Dust Suction Devices and Painting Dust Collectors
- Innovation of Shoulder in the E-Clip Railway Rail Fastening System
- 3R Multi Production Division: Automation of Water Treatment and Distribution Processes to Recycle Water for Rain Testing
- Reuse of Wastewater Effluent with Reverse Osmosis (RO) Mechanism

One of capacity capacity-building activity is depicted in Figure 8.

**Figure 8**
*Capacity Building Activity in Strengthening Environmental Sustainability*

*Source.* Kristina et al. (2024)

Knowledge-sharing mechanisms such as online platform/ digital bulletin boards and peer-led tutorial videos were introduced. These tools enabled rapid dissemination of best practices and reinforced a collaborative learning environment.

**Organizational Impact**

Beyond individual capacity, the program fostered a broader cultural shift. Management began to prioritize environmental metrics in strategic decisions, and sustainability indicators were incorporated into performance reviews. Environmental compliance scores improved during external audits, and the program received recognition from the Indonesian Ministry of Environment and Forestry for innovative environmental education in manufacturing industry. Pindad's sustainability efforts were recognized by national institutions and organizations during the same year as depicted in Figure 9.

**Figure 9**
*BUMN Track and Indonesian Shared Value Institute (ISVI) 2024*


*Source.* Pindad (2024)

Pindad received a prestigious 4-star (Gold) award in the Social Pillar category at the 4th TJSL & CSR Award 2024, presented by BUMN Track and Indonesian Shared Value Institute (ISVI), in recognition of its outstanding social responsibility initiatives.

## Challenges and Limitations

These activities and initiatives, however, also having challenges and limitations so far, such as:

- **Sustainability of Engagement**: Maintaining interest beyond the pilot phase is a concern. Strategies such as gamification and recognition awards are under consideration.
- **Integration with Formal Systems**: Informal efforts need to be institutionalized to ensure long-term continuity.
- **Resource Constraints**: Initial implementation required upfront investment in training materials, devices, facilitation, etc.

## Conclusion

We conclude some points, they are:

- The capacity-building initiative at Pindad demonstrates that informal education can be a powerful lever for environmental sustainability in the industrial sector. It successfully addressed the generational knowledge gap, empowered young employees, and achieved measurable improvements in energy, waste, and emission metrics.
- The program proves that sustainability and productivity can coexist through education and innovation. By harnessing the creativity and values of the millennial workforce, companies like Pindad can lead the transition toward more sustainable industrial practices.

## Recommendations

The are also some of recommendations we would like to follow up in the future, such as:

- Scale the program to reach more employees across divisions and ranks.
- Establish a Sustainability Learning Center to house training modules and serve as a think-tank.

- Formalize links between informal learning outputs and company KPIs.
- Collaborate with external educational institutions and NGOs for content enrichment.
- Conduct longitudinal studies to track long-term behavioural and environmental impacts.

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