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Environmental Literacy and Pro-Environmental Behavior of Coal Mine Workers: An Analysis of the Knowing-Doing Gap in the Implementation of ISO 14001:2015

Febrian[1*], Nurhasan syah[1], Mulya Gusman[1], Syafrijon[1]

[1] Master of Environmental Science, Postgraduate Program, Padang State University (UNP), Padang, Indonesia.

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Corresponding Author:
Febrian
febrian.boestami@gmail.com

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Abstract: This study examines the knowing-doing gap in environmental literacy among coal mine workers implementing ISO 14001:2015 at PT XYZ, South Sumatra. Despite being ISO 14001 certified, the gap between environmental knowledge and actual pro-environmental behavior remains a critical challenge in sustainable mining. Using a mixed-methods design, researchers surveyed 24 workers through questionnaires, semi-structured interviews, field observations, and document analysis. Environmental literacy was assessed through three dimensions: knowledge, attitudes, and behavior, based on the McBeth & Volk framework. Quantitative data were analyzed using descriptive statistics (SPSS 25), while qualitative data were analyzed through thematic analysis. The results indicate high environmental literacy knowledge (83% understand the policy) and positive attitudes (>65% agree with environmental responsibility), but low consistent behavior with only 42% attending regular training and 38% participating in reclamation programs, indicating a 41% gap. Key barriers include productivity pressures, inflexible training schedules, the absence of an incentive system, and weak management role models. ISO 14001:2015 effectively enhances the knowledge dimension through policy dissemination and audits, but fails to drive behavioral change without complementary organizational mechanisms. This research contributes to a conceptual model that integrates individual literacy with organizational determinants, demonstrating that sustainable mining requires systemic interventions beyond administrative compliance.

Keywords: Environmental literacy; ISO 14001; Knowing-doing gap; Pro-environmental behavior; Sustainable mining

Introduction

The mining industry plays a strategic role in Indonesia's economy, contributing 37.38% to the national GDP from 2017 to 2021 (Amalia, 2023). However, mining activities have complex environmental impacts, including deforestation, erosion, water and soil pollution, and loss of biodiversity (Prasetyo et al., 2025). Long term impacts such as land degradation and disruption of ecosystem balance require a comprehensive understanding of ecological principles among mining personnel to promote sustainable practices (Putri et al., 2025; Pouresmaieli et al., 2024). Therefore, environmental literacy the ability of individuals to understand environmental conditions and take appropriate actions to maintain or improve environmental quality is crucial in achieving the environmental and social responsibilities of the mining sector (Guzman et al., 2022).

Environmental literacy consists of four main components, namely understanding of environmental systems, cognitive and affective abilities, perceptions or attitudes towards the environment, and responsible behavior to support the environment (Mcbeth et al., 2010). This multidimensional process does not only convey facts. It also encompasses an understanding of

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how human actions affect the environment. Developing personal responsibility and sustainable pro-environmental behavior is crucial (Yildirim et al., 2025). In the mining industry, workplace literacy is an important component that determines the success of environmental management system implementation; the successful implementation of ISO 14001 in this industry depends not only on technical and administrative elements, but also on human skills, knowledge, and active participation (Alnavis et al., 2021).

However, when high environmental knowledge or pro-environmental attitudes are not translated into consistent pro-environmental behavior, the phenomenon of the "knowledge-doing gap" often occurs (Kollmuss & Agyeman, 2002; Yang et al., 2025). Studies show that workers may know a lot about environmental issues, but that does not necessarily mean they will do something to protect the environment. Incentive systems, availability of training, management commitment, and organizational culture are all factors that contribute to this (Piwowar-sulej et al., 2025). To address this discrepancy, a comprehensive approach is needed that combines effective education and implementation strategies and creates an organizational culture that supports sustainable management and environmental stewardship (Haleem et al., 2025). In the mining industry, environmental management requires an integrated approach that goes beyond administrative regulations. This approach must be supported by management commitment, internal awareness, and an organizational culture focused on sustainability (Astuti et al., 2025; Cestau & Pablo, 2025).

As the international standard for Environmental Management Systems (EMS), ISO 14001:2015 emphasizes that environmental skills and awareness are critical to the success of the system (ISO 2015, 2015; Miguel & Martins, 2015). Clauses 7.2 and 7.3 state that organizations must ensure that employees have knowledge and understanding of environmental policies, key elements, and their roles in improving the efficiency of the Environmental Management System (EMS). However, research shows that the components of competence and awareness are often minimally applied and have not been internalized in daily operational practices (Boiral & Boiral, 2007; Christmann & Taylor, 2006). Research on environmental literacy in the mining sector in Indonesia is still limited and usually focuses on the technical aspects of environmental management and regulatory compliance, while human capital dimensions such as workers' knowledge and behavior regarding the environment have not been widely studied (Amir et al., 2023). It is crucial to understand the level of environmental literacy of mining workers in order to design more contextual and efficient capacity building programs that support sustainable mining practices (Maryati et al., 2022).

PT XYZ is a mining company located in Lahat Regency, South Sumatra, which has been using SML ISO 14001:2015 since 2022. This is the right time to see how much workers' environmental literacy has changed and how much the management system has helped foster pro-environmental behavior. The objectives of this study are as follows: (i) to evaluate the level of environmental literacy among mining workers, including knowledge, attitudes, and behavior; (ii) to find significant differences between environmental knowledge and pro-environmental behavior (knowledge-to-action gap); and (iii) to examine how the implementation of SML ISO 14001:2015 helps improve environmental literacy, as well as the factors that help and hinder the conversion of knowledge.

There are three new findings from this study. First, it is the first systematic study of the knowing-doing gap in mining operations certified by ISO 14001. This complements previous research that focused on non-extractive industries or education. Second, from individual psychological factors to the organizational level, the framework of the gap between knowledge and action has evolved from individual psychological factors to the organizational level. This shows how structural barriers to productivity, leadership role models, training accessibility, and incentive systems help transform environmental knowledge into workplace behavior. Third, this study bridges environmental literacy theory with industrial practice by viewing workplace environmental management as contextual science learning in a non-formal setting. It provides new insights into adult science learning in high-risk work environments. These findings have significant implications for non-formal science education in the industrial sector and sustainable mining practices.

Method

Research Design

This study employed a mixed-methods approach integrating qualitative descriptive methods and quantitative analysis. The population consisted of 150 workers involved in operational and environmental management activities for at least six months. The sample size was determined using purposive sampling based on specific inclusion criteria, namely work experience, involvement in environmentally related activities, understanding of ISO 14001:2015 implementation, and willingness to participate (Creswell & Poth, 2018). A total of 24 respondents were selected, comprising SHE personnel, environmental officers, safety patrol staff, and operational workers. The research variables included environmental literacy

(knowledge, attitudes, and behavior) as the dependent variable and ISO 14001:2015 EMS implementation as the independent variable. Data were collected using Likert-scale questionnaires, semi-structured interviews, participant observation, and document analysis. The research instruments were validated and supported by environmental measurement tools and spatial and statistical analysis software to ensure data accuracy and reliability.

Time and Place of Research

This research was conducted from January to May 2025 at PT XYZ, an andesite mining company located in Lahat Regency, South Sumatra Province, Indonesia (coordinates: approximately 3°47'S, 103°32'E). The company was selected because it has implemented the ISO 14001:2015 Environmental Management System since 2022, making it relevant for examining the relationship between EMS implementation and environmental literacy. PT XYZ operates an open-pit mining system with approximately 150 workers across operational, technical, and administrative divisions. Data collection was conducted over four months, including preliminary observation (January 2025), questionnaire distribution and interviews (February–March 2025), field observation during internal audits (April 2025), and data validation and analysis (April–May 2025).

Research Procedure

The research was conducted through systematic stages from January to May 2025. The initial stage involved a preliminary study, obtaining research permits, and developing and validating research instruments. The second stage included sampling and respondent recruitment in coordination with HRD and K3L divisions. The third stage involved quantitative data collection through structured questionnaires administered to 24 respondents. The fourth stage consisted of qualitative data collection through semi-structured interviews, participant observation of operational activities and internal audits, and document analysis. The final stage involved environmental performance assessment through air quality measurements, GIS-based spatial analysis of reclamation areas, and evaluation of wastewater quality data.

Data Analysis

Data analysis employed both quantitative and qualitative approaches consistent with the mixed-methods design. Quantitative data were analyzed using descriptive statistics with Microsoft Excel 2021 and SPSS version 25 to calculate frequencies, percentages, means, and standard deviations. Gap analysis was conducted to measure the difference between environmental knowledge and behavioral consistency. Environmental performance was evaluated by comparing air quality parameters with regulatory standards and calculating reclamation success rates. Qualitative data were analyzed using thematic analysis following systematic stages of coding, theme development, review, and interpretation as outlined (Najmah et al., 2023).Validity and reliability were ensured through triangulation, member checking, and peer debriefing, adhering to the principles of credibility, transferability, dependability, and confirmability.

Result and Discussion

The results of the study indicate that environmental literacy in the mining industry functions as a type of contextual applied science literacy. Although environmental knowledge transfer was successful, the lack of pro-environmental behavior indicates a gap between knowledge and action, which underscores that conceptual mastery and organizational system and cultural support influence scientific literacy.

Environmental Literacy Level of Mine Workers.

1. Knowledge Dimension

The survey results show that 20 people, or 83% of the 24 respondents, have a good understanding of the company's environmental policy. This level of understanding includes PT XYZ's understanding of the environmental aspects of SML ISO 14001:2015, including important environmental elements of mining operations such as waste, noise, and emissions; the operational control procedures used by the company to reduce its environmental impact; and the environmental objectives and programs that the company has established.

Table 1. Level of Understanding of Environmental Policy

Knowledge Aspect (%)	Understand (%)	Somewhat Understand (%)	Do Not Understand (%)
Company Environmental Policy	83	13	4
Significant Environmental Aspects	79	17	4
Procedures for Operational Control	75	21	4
Environmental Targets and Programs	71	25	4

This high level of understanding shows that the Safety, Health, and Environment (SHE) Division has achieved its goal of increasing public understanding of environmental policy. This is in line with Clause 7.3 of

ISO 14001:2015, which emphasizes how important it is for employees to understand environmental policies, important environmental elements, and how they can help improve SML (Miguel & Martins, 2015);(ISO 2015, 2015). This high level of understanding indicates that the Safety, Health, and Environment Division (K3L) has achieved its goal of increasing public understanding of environmental policies. This aligns with Clause 7.3 of ISO 14001:2015, which emphasizes the importance of employees understanding environmental policies, key environmental elements, and how they can help improve the EMS (Miguel & Martins, 2015);(ISO 2015, 2015).

Several interviewees said, "We are often informed about the company's environmental policies, especially during morning briefings before work." Therefore, we have an understanding of our capacities and limitations" (Respondent 7, Security Patrol). However, this high level of understanding indicates procedural compliance rather than conceptual mastery, as most respondents can explain what actions to take but do not fully understand the ecological impact of each operational action.

2. Behavioral Dimensions

Compared to the knowledge level, the behavioral dimension shows more encouraging results. Only 10 out of 24 respondents indicated that they actively and consistently participated in the company's environmental programs, particularly regular training.

Table 2. Participation in Pro-Environmental Behaviors

Behavior Type	Always (%)	Often (%)	Sometimes (%)	Rarely (%)
Attending regular environmental training	42	29	21	8
Using APD according to procedure	67	25	8	0
Implementing LOTO procedures	54	29	13	4
Reporting potential environmental impacts	50	33	13	4
Participating in reclamation programs	38	33	21	8

This data shows a significant gap between knowledge and behavior, a phenomenon known as the "knowing-doing gap." This finding is consistent with previous research findings (Kollmuss & Agyeman, 2002). Although 83% of employes understand environmental policies, only 42% regularly participate in training and capacity-building programs.

This result aligns with previous research (Alnavis et al., 2021), which found that low training intensity is a major barrier to implementing SML in Indonesian companies. Additionally, (Szymanski & Ustinovichius, 2016) emphasized that employe competence and awareness are important components in the success of ISO 14001.

Field observations indicate that pro-environmental behaviors requiring individual initiative, such as attending training and participating in reclamation programs, are more consistent than behaviors that are directly required and supervised, such as using PPE. This pattern suggests that external control influences compliance more than internal awareness.

However, some practices need improvement, such as the use of Lockout-Tagout/LOTO procedures (46% inconsistent), participation in routine training (58% inconsistent), and participation in 3R (Reduce, Reuse, Recycle) programs, which is still very low.

The interview results indicate several causes of inconsistent behavior: "Training sometimes happens, but it coincides with our shifts, so it's difficult to attend. Training needs to fit in with the job" (Respondent 15, Operations Staff). Additionally, some said, "We know the procedures for LOTO, but sometimes there's time pressure in the field to complete tasks quickly, so procedures are often skipped" (Response 9, Technician).

3. Attitude Dimensions

To measure the dimensions of attitude, respondents were asked to rate statements related to environmental concern and responsibility using a Likert scale.

Table 3. Attitudes Toward Environmental Issues

Statement	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)
I feel responsible for maintaining the environment in the work area.	71	25	4	0
Environmental management is just as important as productivity.	67	29	4	0
I am willing to dedicate time to environmental training.	58	33	8	0
Environmental damage from mining is a shared responsibility.	75	21	4	0

These results indicate that positive attitudes toward the environment are quite high (> 65% strongly agree/agree with all statements). However, there is an inconsistency between attitudes and actual behavior, a

phenomenon known as the "attitude-behavior gap" in environmental psychology literature.

This finding supports Stern's (2000) Value-Belief-Norm (VBN) theory, which states that even if someone has pro-environmental values and beliefs, actual behavior is influenced by contextual factors such as structural barriers, social norms, and perceived behavioral control.

The Gap Between Knowledge and Behavior (Knowing-Doing Gap)

A comparative analysis between the dimensions of knowledge and behavior reveals significant gaps:

Table 4. Gap Analysis: Knowledge vs. Behavior

Aspect	Knowledge Level (%)	Consistent Behavior Level (%)	Gap (%)
Environmental Policy	83	42	41
Control Procedures	75	54	21
Use of APD	79	67	12
Reclamation Program	71	38	33

The largest gaps are in training participation (41%) and involvement in reclamation programs (33%). This shows that although workers know how important these things are, external factors prevent them from turning that knowledge into action.

Based on interviews and observations, the factors causing the gap between knowledge and action are divided into three categories: structural barriers, such as unflexible training schedules that conflict with work shifts, a lack of environmental experts, and a lack of incentives for pro-environmental behavior; operational barriers, such as high productivity pressure that disregards safety procedures, limited support facilities like dust collectors, and daily operational priorities that are more urgent than long-term environmental programs; and organizational culture barriers, such as a weak environmental culture, a lack of role models from management, and weak sanctions for environmental procedure violations.

The interview results revealed that "sometimes our boss tells us to finish the work quickly, so we don't consider the procedure too important. If our boss does it, we'll definitely follow." (Respondent 18, Operator). These findings are consistent with the research by (Carrillo-labella & Fort, 2020), which found that technical and organizational cultural barriers were major obstacles to the implementation of ISO 14001 in many companies. (Piwowar-sulej et al., 2025) also confirmed that effective internal communication and a supportive organizational culture are key to translating knowledge into behavior.

Collective Behavior Outcome: Environmental Performance

To understand the impact of environmental literacy on actual performance, this study analyzes quantitative data on environmental quality as an outcome of workers' collective behavior.

1. *Air Quality and Emissions*

The results of air quality monitoring by the UPTD Environmental Laboratory of South Sumatra Province (2025) show significant variations between locations. Location L1 (982) and L2 (983) show normal conditions with NO_x levels of 286 µg/Nm³ and 303 µg/Nm³, and CO levels of 33.3 µg/Nm³ and 31.4 µg/Nm³. Conversely, location L3 (984) shows a significant increase with NO_x reaching 643 µg/Nm³ and CO at 40.8 µg/Nm³, indicating the need for corrective action.

The high emissions at location L3 are related to suboptimal preventive maintenance practices. Interviews with technicians revealed that routine maintenance schedules were often delayed due to production target priorities, causing machines to not operate optimally and emissions to increase. This finding aligns with the research by (Dayo-olupona et al., 2023), which showed that increasing preventive maintenance programs can reduce CO emissions by up to 18%, confirming that pro-environmental behavior depends not only on individual awareness but also on organizational systems and priorities.

2. *Land Reclamation and Rehabilitation*

Data from PT XYZ's reclamation efforts shows a success rate of only 30% of the target, with backfilling realization reaching 10.85 ha out of a planned 36.39 ha in Block A, while Blocks B and C have not yet shown any realization. This low level of achievement indicates a weak collective commitment, as only 38% of workers consistently participated in the reclamation program.

The low level of participation is due to: (1) a lack of understanding of the importance of reclamation—workers think it's the responsibility of the environmental team; (2) a lack of time because the program is held on holidays without incentives; and (3) the absence of a monitoring or reward system to encourage participation. Still, the company has put in place GIS-based monitoring technology using ArcGIS 10.8 and QGIS 3.22 to get a more accurate picture of how well the revegetation is working, in line with Karan et al.'s (2016) findings on the advantages of remote sensing for monitoring mine reclamation.

3. Waste and Water Management

Although the wastewater quality parameters (pH, TSS, COD) are still below the quality standard, field observations indicate that practices need to be improved. A well-functioning SPARING system (Settling Pond and Recycle), routine monitoring according to schedule, and hazardous waste management according to procedure are examples of positive practices. However, waste sorting in the operational area is not yet optimal, the implementation of the 3R principle is still minimal, and awareness of not throwing away trash carelessly still needs to be strengthened. Environmental Officer said that even though there are separate trash cans, many workers don't use them correctly, so stricter penalties are needed.

Literasi The Role of the ISO 14001:2015 Environmental Management System and Determinant Factors of Literacy

The implementation of SML ISO 14001:2015 at PT XYZ has made a positive contribution to improving environmental literacy, particularly in the knowledge dimension, through several effective mechanisms integrated into the company's management system. The first mechanism is the regular dissemination and communication of environmental policies through pre-work morning briefings, bulletin boards in strategic areas, WhatsApp groups for quick information sharing, and weekly meetings discussing environmental issues. This communication strategy was successful because 83% of respondents said they knew a lot about the company's environmental policies. However, it remains difficult to consistently change behavior in the field.

The second mechanism is internal audit and evaluation, which serves as a means to assess compliance with procedures, identify gaps in implementation, and form the basis for recommendations for continuous improvement. (Szymanski & Ustinovichius, 2016) state that a comprehensive internal audit can improve compliance effectiveness while strengthening the evaluation function within the Plan-Do-Check-Act (PDCA) cycle, which is the backbone of environmental management systems.

The third mechanism is a digital-based environmental reporting system that makes it easier to record incidents in real time, keep track of environmental targets, and make data more accessible to both internal and external stakeholders. However, this system has not yet been linked to an effective reward and punishment system that encourages long-term behavior change.

The effectiveness of implementing SML ISO 14001:2015 is influenced by various supporting and hindering factors that interact dynamically within the organizational context. Supporting factors include a clear and structured SML ISO 14001:2015 framework encompassing policies, audit procedures, and reporting systems; consistent top management support for environmental programs; the existence of a dedicated EHS (Environmental, Health, and Safety) division; and the legitimacy of environmental issues as an organizational priority, which is embedded in the company's vision and mission. On the other hand, the factors that make things harder include the limited intensity and flexibility of training that don't fit with the shift work system, the pressure of productivity targets that often take precedence over environmental procedures in daily operations, the lack of a reward and punishment system that is linked to employee performance evaluations, and the lack of good management examples in the field, which causes a gap between formal policies and actual implementation.

Even though there are many problems, there are strategic opportunities for companies to improve environmental literacy. These opportunities include integrating the 3R program (Reduce, Reuse, Recycle) into daily operational activities so that it becomes part of the work routine, developing competency-based training with a hands-on approach and problem-based learning in the field that is more applicable, strengthening internal capacity through an environmental auditor certification program for key personnel, implementing a systematic reward and recognition system for pro-environmental behavior to create extrinsic motivation, establishing environmental ambassadors in each work unit as change agents who can inspire their coworkers, collaborating with universities in environmental research and innovation to access the latest knowledge, and utilizing digital technology for real-time monitoring and geographic information systems (GIS) to improve monitoring accuracy and response speed to environmental issues.

This finding reinforces the research conducted by (Agan et al., 2013) and (Dyllick & Muff, 2016), which underscores that enhancing environmental literacy in the mining industry necessitates an integrated approach that aligns formal management systems, organizational culture, and behavioral incentives to achieve a substantial and enduring transition towards sustainable practices.

Conceptual Model of Environmental Literacy for Mine Workers

Based on the research findings, a conceptual model (Figure 1) was developed, indicating that environmental literacy among mine workers, encompassing the dimensions of knowledge, attitudes, and behavior, is not linear. A relatively high level of pro-environmental knowledge and attitude has not automatically led to consistent pro-environmental behavior. Converting

knowledge into action is influenced by organizational and contextual moderating factors.

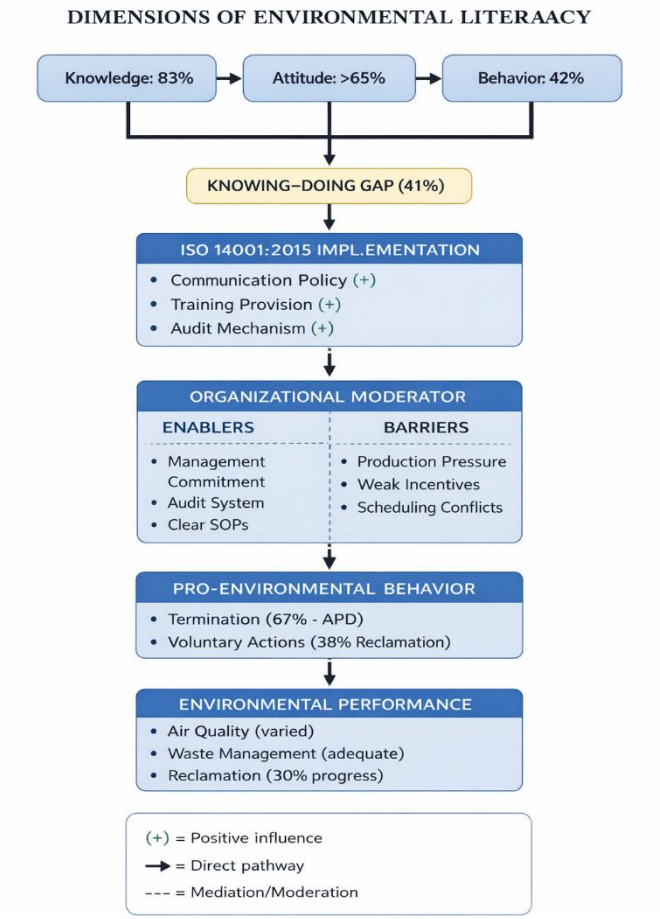

Figure 1. Conceptual Model of Environmental Literacy and Knowing-Doing Gap in the Context of Coal Mining with the Implementation of ISO 14001:2015

As shown in Figure 1, supporting factors like management commitment, regular internal audits, and a digital reporting system help strengthen formal awareness and compliance. On the other hand, factors that make it harder to internalize environmental values in everyday work include pressure to be productive, limited training, and a lack of incentives and role models in management. The interaction between these supporting and hindering factors creates a knowing-doing gap of 41%, which is larger for voluntary behavior (participation in reclamation: 38%) than for monitored behavior (use of APD: 67%).

The pro-environmental behavior of workers, formed through the interaction of these factors, subsequently determines the company's environmental performance, such as air quality, waste management, and successful land reclamation. This model confirms that the effectiveness of an Environmental Management System in the mining industry is highly dependent on its ability to build behavior reinforcement mechanisms integrated with organizational culture and incentive systems, rather than solely on knowledge improvement or administrative compliance.

Theoretical and Contextual Implications

Empirical findings reveal a consistent pattern: despite workers' environmental literacy showing high dimensions of knowledge (83%) and attitudes (>65%), a 41% knowing-doing gap indicates a failure to convert knowledge into consistent behavior. This gap is not evenly distributed—monitored behavior (use APD: 67%) shows higher compliance compared to voluntary behavior (reclamation participation: 38%), indicating that organizational control plays a crucial role.

The implementation of ISO 14001:2015 has proven effective as a system for knowledge improvement through socialization mechanisms, audits, and digital reporting. However, its effectiveness in driving behavioral change is hampered by structural factors (inflexible training schedules, lack of incentives), operational factors (productivity pressure), and cultural factors (weak management role modeling). Environmental performance outcomes varying air quality, 30% reclamation achievement, and waste management practices that still need improvement reflect the collective impact of these gaps.

Theoretical Contribution

1. *Expanding the Knowing-Doing Gap Framework*

Expanding the framework of the knowing-doing gap (Kollmuss & Agyeman, 2002) from the individual psychological level to organizational determinants. The findings indicate that the predictive gap varies according to behavior type: behaviors with direct monitoring (use of APD: 67%) are more consistent than voluntary behaviors (participation in reclamation: 38%), reflecting a 29-percentage point difference. This suggests that in an industrial setting, compliance is more a response to the organizational oversight system than to the individual environmental value function. This contribution aligns with institutional theory regarding symbolic versus substantive compliance (Christmann & Taylor, 2006), yet it demonstrates that this dynamic functions not only at the organizational policy level but also at the micro level of worker behavior.

2. *Reconceptualizing ISO 14001:2015*

Reconceptualizing ISO 14001:2015 as a cognitive intervention system rather than a behavioral intervention system. This standard effectively increases knowledge (83% good understanding) but fails to ensure behavioral translation without complementary organizational mechanisms such as performance integration, incentive alignment, and leadership modeling. This finding elucidates the inconsistencies in

the literature regarding the impact of ISO 14001 on environmental performance (Boiral & Boiral, 2007; Kojra, 2020) the effectiveness of ISO 14001 is mediated by organizational context variables that are not specified within the standard itself.

3. *Sains Environmental Literacy as Science Learning*

Understanding workplace environmental literacy as contextual science learning in a non-formal setting. This perspective bridges science education theory with organizational behavior research, providing insights into how scientific knowledge is constructed and applied in adult populations outside the formal education system (Cole, 2019; Gu et al., 2023). This is important because global industries are adopting better cooperative practices in the workplace. Miners acquire environmental knowledge through various channels, including formal training, operational practices, interactions with colleagues, and SML procedures.

Practical Implications

The research identified four key strategies for improving environmental literacy in the mining industry:

1. Building a behavioral reinforcement system: Establishing a system that incorporates environmental standards into performance evaluation systems and creates mechanisms that identify environmentally supportive behaviors independent of sanctions. The incentive system must align with environmental responsibility.
2. Increase training accessibility: Use actual problem-based learning approaches and field practice, design competency-based training programs with flexible schedules that allow for shift systems, and form environmental representatives in each work unit as agents of change.
3. Strengthening leadership examples: ensuring that formal policies align with field management practices, establishing a supervisor accountability system to achieve their unit's environmental goals, and creating an organizational culture where sustainability is equated with productivity.
4. Removing structural barriers: Providing adequate support facilities, such as waste collectors, high-quality PPE, and segregated waste bins; resolving conflicts between production targets and environmental procedures through integrated operational design; and using digital technology for real-time GIS-based reporting and monitoring to improve transparency and rapid response.

Overall, the transition toward sustainable mining practices requires a comprehensive approach. This approach should integrate organizational culture, incentive structures, and formal management systems. This must go beyond administrative compliance to internalize environmental values in daily operations (Agan et al., 2013; Dyllick & Muff, 2016).

Conclusion

The level of environmental literacy among coal mine workers at PT XYZ is moderate, with relatively high levels of knowledge and attitude, but not yet consistent pro-environmental behavior. These findings indicate a significant knowing–doing gap, particularly regarding participation in environmental training and involvement in land reclamation programs. The implementation of the ISO 14001:2015 Environmental Management System has been effective in raising environmental awareness and knowledge through socialization, internal audits, and digital reporting. However, this system has not yet been able to fully encourage behavior change because it is not yet supported by adequate behavior reinforcement mechanisms, such as incentive systems, management role modeling, and reduction of structural barriers in the field.

The performance of the environment as a collective outcome shows different results. For example, the quality of the air and the management of wastewater are relatively stable, but the reclamation of land is still low. This emphasizes that the success of environmental management in the mining industry is highly dependent on the integration of worker environmental literacy, organizational management systems, and a work culture that promotes sustainable practices.

Overall, this research confirms that improving environmental literacy in the mining industry requires an approach that focuses not only on increasing knowledge, but also on shaping behavior through systemic organizational interventions. This finding provides empirical contributions to the development of environmental literacy theory within the industrial context and serves as a foundation for formulating more effective and sustainable environmental performance improvement strategies.

The study has limitations due to the relatively small number of respondents and the limited geographic scope, involving only one mining company, necessitating cautious generalization of the findings. It is suggested that the next research use a wider range of locations and a longitudinal design.

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Conceptualization, F.B.; methodology, F.B. and M.G.; software, F.B.; validation, N.S., M.G., and S.R.; formal analysis, F.B.; investigation, F.B.; resources, F.B.; data curation, F.B.; writing original draft preparation, F.B.; writing review and editing, N.S., M.G., and S.R.; supervision, N.S.; project administration, F.B.

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