**Jurnal Presipitasi**
Media Komunikasi dan Pengembangan Teknik Lingkungan
e-ISSN: 2550-0023

Vol 23, No 2, 2026, 612-624
Article available at homepage presipitasi

*Regional Case Study*

# Analysis of The Implementation of The Iso 14001:2015 Environmental Management System at Manufacturing Industry

**Budi Prasetyo Samadikun[1*], Himawan Aziz Muftiansyah[1], Nani Anggraini[2]**

[1] Department of Environmental Engineering, Faculty of Engineering, Diponegoro University, Jalan Prof. Soedarto, SH, Semarang, Indonesia 50275

[2] Graduate Programs in Environmental Systems, Graduate School of Environmental Engineering, The University of Kitakyushu, 4-2-1 Kitagata, Kokuraminami-ku, Kitakyushu, Fukuoka, Japan 808-0135

[*] Corresponding Author, email: budisamadikun@lecturer.undip.ac.id

*Copyright © 2026 by Authors,*
*Published by Environmental Engineering Department,*
*Faculty of Engineering, Universitas Diponegoro*
*This open access article is distributed under a*
*Creative Commons Attribution 4.0 International License*

## Abstract

ISO 14001:2015 is an international standard created by the International Organization for Standardization which regulates Environmental Management Systems (EMS) to help companies manage their environmental impacts and achieve continuous improvement. The manufacturing industry, a foreign investment company in diesel engine production, implements EMS as part of its commitment to environmental sustainability. This study evaluated the implementation of ISO 14001:2015 by comparing each clause with actual practices. Data were collected through field observations and document reviews. The results show that the manufacturing industry successfully implemented all clauses of ISO 14001:2015. However, improvements are still required to increase employee awareness. This study provides a structured approach to EMS evaluation by integrating clause-based ISO with real practices that can serve as a reference for other industries to improve EMS performance.

**Keywords:** Clause-based evaluation; continuous improvement; environmental management system; ISO 14001:2015; operational control

## 1. Introduction

Environmental issues have always been a hot topic of discussion throughout the year. Along with the development of the industrial world, environmental conditions continue to change. Increasing human needs, driven by the growing population, lead to increased production activities by companies to meet those needs. Consequently, environmental pollution levels are likely to increase. To prevent pollution, all parties must work together to ensure sustainable environmental preservation for future generations (Fahmi, 2021). The government, society, and environmental organizations must collaborate to ensure that companies operate in accordance with the applicable regulations set by international, national, and local standards. Companies are also expected to develop sustainable environmental management strategies and policies, such as water management, hazardous waste management, and air pollution control (Susilo 2020).

One globally accepted environmental management strategy is the implementation of International Organization for Standardization (ISO) standards (Maryeska et al., 2020). According to Hidayat (2020), ISO 14001 provides a framework for industries to implement environmentally friendly and community-oriented management systems in addition to company profit. ISO 14001 provides a

framework for companies to implement environmentally friendly and community-oriented management systems. The ISO 14001 standard promotes a detailed approach to pollution reduction through the implementation of an environmental management system (EMS) based on four iterative steps: 1) Plan: develop a firm's environmental policy, identify the environmental aspects of the firm's operations, and set objectives and targets for environmental performance improvements; 2) Do: implement the plan; 3) Check: monitor the environmental system and measure environmental improvements; and 4) Act: review and act as necessary to meet the stated objectives (Song, 2024). With ISO 14001, it is hoped that companies can reduce negative environmental impacts and strengthen positive ones through the implementation of environmental management strategies (Testa, 2018). Companies that adopt ISO 14001 will also gain a better image, as it demonstrates their commitment to environmental management systems that meet international standards (BSN, 2015).

Several previous studies have discussed the implementation of ISO 14001:2015 in industrial sectors, particularly focusing on environmental compliance, certification benefits, and general environmental management performance. Song (2024) explained the correlation between ISO 14001 and environmental performance, and Testa (2018) explained the use and output of ISO 14001 implementation in industries. Many previous studies have emphasized compliance evaluation and organizational performance, with few discussions on the correlation between each clause and actual practices in industries. This study focuses on clause-based implementation to provide a more practical evaluation framework.

The manufacturing Industry is an example of a company that faces several environmental pollution problems from its production. The production of diesel engines has a high potential to create hazardous liquid waste and air pollution from different production processes. The manufacturing Industry attempts to maintain the quality of products and minimize risks to the environment.

Observations were conducted at a manufacturing industry located in the Bukit Semarang Baru (BSB) Industrial Area. This company has been ISO 14001:2015 certified since 2006 by Lloyd's Register (UK). All monitoring activities are implemented in accordance with the relevant government regulations. The manufacturing Industry has integrated policies with other management systems, including the ISO 9001:2015 Quality Management System and the Occupational Health and Safety Management System based on Government Regulation Number 50 of 2012, aimed at reducing workplace accidents and improving production efficiency. The manufacturing Industry has also established an "Occupational Health and Safety Policy" and a "Quality and Environmental Policy" as part of the implementation of ISO 14001:2015, which ensures that all parties involved with the manufacturing industry comply with and understand the importance of maintaining occupational health and safety, as well as the importance of preserving environmental quality to avoid negative impacts on the related parties.

Several previous studies have discussed the implementation of ISO 14001:2015 in industrial sectors, mainly focusing on certification benefits, environmental compliance, and general environmental performance. However, few studies have specifically evaluated how each ISO 14001:2015 clause is translated into actual operational practices at the industrial level. Therefore, this study aims to provide a comprehensive clause-based analysis of ISO 14001:2015 implementation in the manufacturing industry by linking standard requirements with real environmental management practices in the company.

To maintain the sustainability of the environmental management system in the manufacturing industry, the application of an environmental management system in accordance with the international standard ISO 14001 is crucial. This standard serves as a benchmark to determine whether environmental quality control is performed in accordance with the clauses set out in ISO 14001:2015. If an organization successfully meets these standards, the ISO 14001:2015 certification will be granted, with the hope that its implementation will continue for future generations.

This study aimed to analyze the implementation of ISO 14001:2015 in the manufacturing industry using a clause-by-clause evaluation approach to identify existing gaps and areas for improvement. The

scope of this study is limited to environmental management in production areas, focusing on environmental monitoring and improvement.

## 2. Methods

This research was conducted at the Manufacturing Industry located at Jl. Taman Industri Bukit Semarang Baru, Mijen District, Semarang City, Central Java. The observation period is being held in 23 days from January 6, 2025, to February 7, 2025. The research consists of the preparation, implementation, and writing phases. Data collection was conducted in two ways: primary and secondary. Primary data collection was completed through observation during the research, and secondary data collection was completed with data gathered from reports and data obtained from the company. The analytical process was conducted using a comparison in which each ISO 14001:2015 was evaluated and compared to the actual implementation. The evaluation process is conducted through the following steps: identification of ISO requirements, mapping of existing company practices, gap identification, and formulation of improvement recommendations.

## 3. Result and Discussion

### 3.1 ISO 14001:2015 Profile at Manufacture Industry

The manufacturing Industry is committed to continuously improving the implementation of the ISO 14001:2015 Environmental Management System (EMS). This standard aims to regulate the overall condition of an organization in managing environmental impacts. Mapping is conducted to identify obstacles in the environmental management system so that improvements can be made in a timely manner. The implementation of ISO 14001:2015 EMS involves seven key clauses: organizational context, leadership, planning, support, operation, performance evaluation, and improvement. These clauses are covered in ISO 14001:2015, from Clause 4 to Clause 10.

### 3.2 Analysis Based on Clause 4 of ISO 14001:2015 (Context of the Organization)

Each organization has different interests depending on the activities carried out by the organization and the stakeholders who are influenced by and influence the organization. Stakeholders are those who can affect the organization and can be affected by activities and decisions within the organization (Karuniasa, 2020). Clause 4 of ISO 14001:2015 contains several connected elements that describe how the manufacturing industry builds its environmental management foundation. The first part is Clause 4.1, which requires the company to identify internal and external issues that influence its operations, strategic direction, and ability to achieve intended outcomes. The manufacturing Industry evaluates internal conditions such as organizational culture, company objectives, product characteristics, information flow, process flow, organizational size, and market position. One internal issue is the difficulty in balancing customer demand with production capacity, which forces the company to use a continuous three-shift system for twenty-four-hour operations, while manpower remains limited. Another internal concern is the low environmental awareness of its employees, in which workers still ignore personal protective equipment. External issues in this company include ongoing changes in environmental regulations, which require rapid adjustment of procedures. There is also competitive pressure from similar industries that can reach remote areas outside Java more effectively, which affects the company's market position.

The next part is Clause 4.2, which requires organizations to understand the needs and expectations of interested parties (Rahman, 2021). The manufacturing Industry decides which stakeholders have an interest in and may be affected by its environmental performance. Management reviews these expectations to decide which become binding obligations for the company. Clause 4.3 defines the boundaries of the environmental management system by limiting the certification scope only to the head office located in Taman Industri Bukit Semarang Baru, Mijen, Semarang. This scope includes

all environmental aspects in the head office area, including wastewater treatment, temporary waste storage, and production areas.

The final part is Clause 4.4, which establishes, implements, maintains, and continually improves its environmental management system to enhance environmental performance, support continuous improvement, and meet all applicable legal requirements. The environmental management system operates as part of the company's integrated management approach, which includes ISO 9001:2015 for quality and Occupational Health and Safety Management System based on Government Regulation Number 50 of 2012 for occupational health and safety. The company has been certified to ISO 14001:2015 by Lloyd's Register since 2006, which confirms its long-term commitment to structured environmental management. The key findings and recommendations of ISO 14001:2015 implementation in Clause 4 are summarized in Table 1.

**Table 1.** Comparison of clause 4 requirements and their implementation

| Clause | Existing Implementation | Gap/Limitation | Recommendation |
|---|---|---|---|
| 4.1 | Identified internal issues (manpower limitation, 3-shift system, low PPE awareness) and external issues (regulation changes, competition) | No structured prioritization or quantification of risks (no scoring system, no matrix analysis) | Apply risk assessment tools such as likelihood-impact matrix or SWOT integrated with EMS to rank environmental risks |
| 4.2 | Stakeholders identified comprehensively (government, community, employees, investors, suppliers, etc.) | No stakeholder prioritization (no power-interest mapping) | Develop stakeholder mapping matrix (power vs interest) to prioritize engagement and compliance strategy |
| 4.3 | Scope limited to head office facility (BSB Industrial Area) including production and WWTP | Scope excludes external operations and supply chain impacts | Expand EMS scope gradually or integrate lifecycle perspective (LCA-based boundary expansion) |
| 4.4 | EMS implemented and integrated with ISO 9001 and SMK3, certified since 2006 | Performance evaluation still compliance-based, not performance-based | Introduce KPI-based EMS (emission intensity, water efficiency, waste reduction rate) |

### 3.3 Analysis Based on Clause 5 of ISO 14001:2015 (Leadership)

Clause 5 Leadership begins with Clause 5.1. Top management needs to improve environmental management, clearly define goals, responsibilities, and accountabilities, create greater awareness and understanding of environmental issues, and improve corporate culture (Petroni, 2001). Top management in the manufacturing industry holds full responsibility for establishing, implementing, and maintaining environmental policies while demonstrating active leadership in the operation of the environmental management system. The president director, as the highest authority in the company, ensures that production processes operate in accordance with the requirements of the environmental management system and oversees the execution of audits and the implementation of ISO 9001:2015, ISO 14001:2015, and Occupational Safety and Health Management System based on the Government Regulation Number 50 of 2012. Leadership commitment is demonstrated through several actions, including setting and communicating company policies, establishing a management system manual and related technical guidelines, conducting management reviews, taking accountability for system effectiveness, ensuring that quality, environmental, and occupational safety policies align with the organizational context and strategic direction, integrating system requirements into business processes, securing the resources

needed for the management system, communicating the importance of effective management to all personnel, and ensuring that the system achieves its intended results.

Clause 5.2 requires top management to clearly state an environmental policy that is consistent with the organization's purpose. In the manufacturing industry, the environmental policy is created by the president director under the title Quality and Environmental Policy. This policy created the foundation for the company's environmental management system and aligned with ISO 9001:2015 and ISO 14001:2015. The company promises to produce high-quality products that can increase national economic growth. This commitment is reflected, for example, in delivering reliable and high-quality products and services, maintaining controlled and efficient processes that avoid environmental pollution, meeting all legal and other applicable requirements, and pursuing continuous improvement of system effectiveness. The policy is communicated to all workers and is also available to external parties as a guiding reference for quality and environmental management.

Another component of Clause 5 is Cause 5.3. Top management must ensure that relevant roles, responsibilities, and authorities are defined, communicated, and implemented throughout the organization. The manufacturing Industry places this responsibility under the leadership of the president director, who assigns authority to ensure that the environmental management system functions effectively and complies with applicable requirements. The company appoints a Management Representative who acts on behalf of top management to coordinate the implementation of ISO 9001:2015, ISO 14001:2015, and Occupational Health and Safety Management System based on Government Regulation No. 50 of 2012. The key findings and recommendations for the implementation of ISO 14001:2015 in Clause 5 are summarized in Table 2.

**Table 2.** Comparison of clause 5 requirements and their implementation

| Clause | Existing Implementation | Gap/Limitation | Recommendation |
|---|---|---|---|
| 5.1 | Top management (President Director) responsible for EMS, ensures implementation, audits, policy alignment, and resource provision | Leadership demonstrated formally, but behavioral enforcement at operational level is inconsistent (e.g., PPE non-compliance still occurs) | Strengthen enforcement mechanisms through supervision, KPI linkage, and behavioral-based safety programs |
| 5.2 | Environmental policy established, integrated with quality policy, communicated internally and externally | Policy communication exists but effectiveness in influencing employee behavior is limited | Enhance policy internalization through regular training, visual control, and measurable awareness evaluation (e.g., competency testing) |
| 5.3 | Roles defined, Management Representative appointed to coordinate ISO systems | Responsibility distribution exists, but accountability at lower operational levels is not fully enforced | Define clear accountability matrix (RACI) and integrate responsibilities into performance appraisal system |

### 3.4 Analysis Based on Clause 6 of ISO 14001:2015 (Planning)

Clause 6 continues the planning framework of the environmental management system and begins with Clause 6.1 Actions to Address Risks and Opportunities, which establishes how the manufacturing industry develops, applies, and maintains the processes needed to fulfill all planning requirements. The company evaluates the internal and external conditions that can influence decision-making and operational control.

This planning requirement continues in Clause 6.1.2. Sunu (2001) explained that effective environmental management requires companies to develop and maintain written procedures to identify

environmental aspects of activities, products, or services that have the potential for significant environmental impact. The HIRADC was created to identify hazards, evaluate the likelihood and consequences of potential impacts, and determine controls for each activity. All environmental aspects are recorded in the ASDAM document, which uses severity probability evaluation to decide which aspects are significant and require higher priority.

The next clause is Clause 6.1.3. Kuhre (1995) explained that organizations must identify all regulations related to their operational activities, which requires the manufacturing industry to identify all regulatory requirements relevant to each activity. After identifying environmental aspects, the company reviews all regulations to determine which obligations should be applied. The planning continues in Clause 6.1.4, in which the manufacturing industry determines the actions needed to address risks and opportunities. The company reviews the details of the HIRADC and ASDAM, especially the severity, probability, and control analysis, to decide which aspect is important. The next clause is Clause 6.2.1, which requires the manufacturing industry to define objectives that are suited to the environmental policy and the company's commitment to continual improvement. These objectives must be measurable, monitored, communicated, and regularly updated. All changes related to environmental objectives are conducted by considering the purpose of the change and its potential impacts. Clause 6.2.2 describes how the manufacturing industry manages its environmental management to meet the targets. Since production activities create various types of waste, the company builds waste management systems that include solid waste, wastewater, and hazardous waste. Domestic waste is separated into categories and stored in containers before collection by the industrial estate operator.

Hazardous waste is segregated, logged in a waste book, and stored in a hazardous waste facility for no longer than the maximum permitted period. Subsequently, licensed third parties collect the waste for treatment, processing, or recovery. Storage procedures follow legal requirements that instruct the company to organize waste according to its characteristics, prevent spills or contamination, especially for materials that are flammable or reactive, apply good housekeeping, and document all incoming and outgoing waste quantities in a hazardous waste balance sheet. The key findings and recommendations for the implementation of ISO 14001:2015 in Clause 6 are summarized in Table 3.

**Table 3.** Comparison of clause 6 requirements and their implementation

| Clause | Existing Implementation | Gap/Limitation | Recommendation |
|---|---|---|---|
| 6.1.1 | Evaluation of internal and external factors conducted, aligned with Clause 4 and stakeholder expectations | Risk and opportunity assessment not quantitatively evaluated (no scoring or prioritization system) | Implement structured risk assessment (likelihood–severity matrix) integrated into EMS planning |
| 6.1.2 | Environmental aspects identified under normal, abnormal, and emergency conditions using HIRADC and ASDAM | Aspect evaluation still semi-qualitative, limited transparency in threshold for "significant" classification | Define quantitative thresholds and scoring criteria for aspect significance determination |
| 6.1.3 | Applicable regulations identified (national, regional, international), integrated into EMS | No clear system for continuous legal update tracking and compliance verification automation | Develop digital legal register and periodic compliance audit system |
| 6.1.4 | Actions derived from HIRADC and ASDAM results, including control and mitigation measures | Action planning not clearly linked to measurable environmental performance indicators | Link each action plan with specific KPI (e.g., emission reduction %, waste reduction rate) |

| Clause | Existing Implementation | Gap/Limitation | Recommendation |
|---|---|---|---|
| 6.2.1 | Objectives derived from environmental aspects, risks, and legal requirements | Objectives are defined but lack quantitative targets and time-bound indicators | Adopt SMART objectives (Specific, Measurable, Achievable, Relevant, Time-bound) |
| 6.2.2 | Detailed waste management system implemented (solid waste, wastewater, hazardous waste) including WWTP processes | Strong operational system, but limited performance evaluation metrics and optimization analysis | Introduce performance monitoring (BOD/COD removal efficiency, water reuse %, waste recovery rate) |

### 3.5 Analysis Based on Clause 7 of ISO 14001:2015 (Support)

Clause 7 explains the support elements required for the effective operation of the environmental management system. Clause 7.1 emphasizes that the company must provide adequate resources, including human resources, natural resources, infrastructure, technology, and financial support. Competent personnel are essential for ensuring that the system functions effectively and that environmental performance improves. Proper placement of employees based on their competence and capacity allows for efficient work performance.

Clause 7.2 explains the company's commitment to involving employees in training and capacity building related to environmental management, which is achieved through human resource planning and management, including seminars, training programs, and professional certification across all departments (Putra, 2024).The objective is to strengthen employee awareness and capability so that environmental responsibilities are understood and reflected in their daily work. The manufacturing Industry determines job positions, job descriptions, and competence requirements, identifies training needs and supporting actions such as counseling, coaching, recruitment, rotation, or promotion, and conducts training to close competency gaps while evaluating its effectiveness. Several employees in the General Affairs – Environment department hold professional certifications issued by the National Professional Certification Agency, including certifications for water pollution control, air pollution control, hazardous waste characterization, and wastewater treatment.

Clause 7.3 explains that top management must ensure that personnel working under the organization's control understand the company's environmental policy, the significant aspects and related actual or potential impacts associated with their work, and their contribution to the effectiveness of the environmental management system. The manufacturing Industry strengthens awareness through policy communication in presiding policy meetings and visual communication by displaying environmental policy posters in strategic areas alongside occupational health and safety signage. Additional programs are conducted to raise awareness, such as morning checks, safety flashes, Kiken Yochi Training, the Five Genba Principles, Safety Man and Safety Dojo activities, Safety Board, XXX Environmentally Friendly Human Guidelines, basic training, and Stop, call, and wait instruction.

Clause 7.4.1 requires companies to ensure that information is communicated internally across all levels and functions. The communication process must also allow personnel under the company's control to contribute to the continual improvement. The manufacturing Industry conducts internal and external communication as part of this requirement. Clause 7.4.2 Internal Communication follows both top-down and bottom-up channels. These include morning checks, internal audits, management reviews, bulletin boards, email communication and telephone communication. Clause 7.4.3, External Communication, involves interaction with interested parties outside the organization. Public information is accessible through the company's official website. Additional communication, especially with customers, is conducted through social media platforms such as Instagram and Facebook, which provide product information, responses to stakeholder inquiries, and feedback, including complaints, expectations, and positive or negative comments.

Clause 7.5.1 ensures that information is accessible and traceable to the user. The manufacturing Industry evaluates the form of documentation by considering document availability, storage format, authorized personnel for approval and revision, and document identification systems. The documentation is structured into several levels. The first level consists of the manual and the Global XXX Standard, which serves as overarching guidance for the system, including vision, mission, values, scope, key elements of ISO standards, and system process interactions. The second level contains procedures developed by relevant units and approved by authorized officials, describing the process details and cross-functional monitoring and control. The third level contains work instructions, developed and approved by the respective units, providing specific steps needed to perform tasks, along with references to internal and external documents. The fourth level consists of records that serve as evidence of activity implementation, including logbooks, check sheets, measurement results, business plans, policies, objectives, and organizational structure. Clause 7.5.2 ensures clarity and traceability by applying a uniform format that includes the XXX logo, title, related department, document number, revision number, issuance date, and signature of an authorized leader. In accordance with ISO 14001:2015, documents must clearly identify their title, date, and author, specify the format, including language and media, and undergo formal review and approval.

The last part of Clause 7 is Clause 7.5.3. The manufacturing Industry maintains procedures to manage all documents and data required by the environmental management system so that documents are archived, reviewed, updated, and approved periodically. The current versions must be available at all relevant locations. Outdated documents must be removed or clearly identified to prevent their unintended use. The key findings and recommendations for ISO 14001:2015 implementation in Clause 7 are summarized in Table 4.

**Table 4.** Comparison of clause 7 requirements and their implementation

| Clause | Existing Implementation | Gap/Limitation | Recommendation |
|---|---|---|---|
| 7.1 | Resources provided (HR, infrastructure, financial support, technology) to support EMS implementation | Resource adequacy not evaluated using performance indicators or workload analysis | Conduct resource optimization analysis (workload vs manpower, environmental task coverage) |
| 7.2 | Training programs conducted, certifications held (air, water, B3, WWTP operators) | Competence evaluation focuses on certification, not actual performance validation | Implement competency-based assessment (practical evaluation, periodic re-certification, on-site performance audit) |
| 7.3 | Awareness programs implemented (morning checks, safety talks, safety dojo, visual posters) | Awareness activities are routine but not measured for effectiveness | Introduce awareness KPI (compliance rate, behavioral observation score, incident correlation) |
| 7.4.1 | Communication through meetings, audits, emails, boards, and external platforms (website, social media) | Communication exists but lacks structured feedback and effectiveness measurement | Develop structured communication flow with feedback loop and response time indicators |
| 7.4.2 | Top-down and bottom-up communication implemented | No formal system to evaluate communication clarity and consistency across departments | Standardize communication protocols and conduct periodic communication audits |

| Clause | Existing Implementation | Gap/Limitation | Recommendation |
|---|---|---|---|
| 7.4.3 | Public information via website and social media, interaction with customers and stakeholders | External communication focuses on information delivery, not stakeholder engagement evaluation | Integrate stakeholder feedback system into EMS evaluation process |
| 7.5.1 | Documentation structured into levels (manual, procedures, work instructions, records) | Documentation is complete but usability and accessibility in field conditions not evaluated | Simplify critical procedures and ensure real-time accessibility (digital or visual SOPs) |
| 7.5.2 | Standardized format applied (logo, numbering, approval system) | Document updates exist but some MSDS found outdated in field | Implement strict document review cycle and digital tracking system for updates |
| 7.5.3 | Procedures for document control implemented and archived systematically | Control system exists but enforcement at operational level is inconsistent | Introduce document control audit and version verification at point of use |

### 3.6 Analysis Based on Clause 8 of ISO 14001:2015 (Operation)

Clause 8 of ISO 14001:2015 focuses on operations. Clause 8.1 involves activities aimed at achieving organizational environmental objectives and targets. Consequently, organizations must systematically establish, implement, control, and maintain processes that ensure conformity with environmental management system requirements (Rizal et al. 2016). The manufacturing Industry manages environmental impacts by identifying significant environmental aspects and planning controls that align with policies, objectives, and established procedures. All production activities are carried out based on documented processes, ensuring that maintenance criteria related to environmental protection are defined and maintained. Suitable equipment is selected to keep maintenance activities consistent with the planned requirements, and the company provides the necessary tools and methods for environmental monitoring and measurement within operations.

The standard then continues to Clause 8.2, which requires the company to anticipate and manage potential emergency situations that may threaten employee safety, the community, or the environment. The manufacturing Industry has developed evacuation routes, fire extinguishers, hydrants, emergency eye wash stations, and other safety equipment in all areas. The Occupational Safety and Health Advisory Committee appoints an emergency response team. The team leader coordinates actions and reports to the committee, while the Human Resources Department ensures that team members receive adequate training. Emergency drills are conducted at least once a year using scenarios that simulate fires, hazardous material spills, poisonings, or natural disasters. The key findings and recommendations for ISO 14001:2015 implementation in Clause 8 are summarized in Table 5.

**Table 5.** Comparison of clause 8 requirements and their implementation

| Clause | Existing Implementation | Gap/Limitation | Recommendation |
|---|---|---|---|
| 8.1 | Operational control implemented through documented procedures, environmental aspect identification, and monitoring activities; production processes follow defined standards | Operational control is procedure-based but lacks real-time monitoring and performance validation | Implement real-time monitoring systems (online sensors for WWTP, emission monitoring) integrated with control systems |
| 8.2 | Emergency systems available (APAR, hydrants, eyewash, | Emergency drills conducted periodically, but effectiveness | Introduce emergency response KPI (response time, |

| Clause | Existing Implementation | Gap/Limitation | Recommendation |
|---|---|---|---|
| | evacuation routes), emergency team formed, drills conducted annually | and response time are not quantitatively evaluated | evacuation time, drill performance score) |

### 3.7 Analysis Based on Clause 9 of ISO 14001:2015 (Performance Evaluation)

Companies are required to monitor their operational performance to determine the achievement of defined objectives and targets. Where objectives are not met, appropriate corrective actions are applied to ensure conformity and performance improvement (US Environmental Protection Agency 2016). Clause 9 of ISO 14001:2015 addresses performance evaluation, which includes Clause 9.1.1, wherein the manufacturing industry conducts scheduled monitoring of activities with significant environmental impact. The company follows the Environmental Management Plan and Environmental Monitoring Plan and conducts regular assessments of ambient air quality, odor, wastewater quality, stationary and mobile emissions, RO drinking water, clean water consumption, and domestic wastewater. These measurements were conducted by PT Syslab.

In Clause 9.1.2, the company conducts a review of legal requirements to ensure that all obligations are met. This evaluation is also in line with participation in the national PROPER KLHK program monitored by the Ministry of Environment and Forestry. In Clause 9.2, internal audits are required to examine conformity with the ISO 14001 requirements and internal organizational procedures. Internal auditors review system implementation according to documented procedures and environmental objectives (Whitelaw, 2004). The internal audit includes planning, defining the scope and methods, assigning auditors, conducting the audit independently, and reporting the results for corrective action.

Clause 9.3 requires an evaluation of the environmental management system each year. In the manufacturing industry, the president director conducts this review to evaluate the suitability, effectiveness, achievement of objectives, and the need for improvement. This review also includes follow-up from previous reviews, audit results, stakeholder feedback, and regulatory changes that can affect the system. The key findings and recommendations for ISO 14001:2015 implementation in Clause 9 are summarized in Table 6.

**Table 6.** Comparison of clause 9 requirements and their implementation

| Clause | Existing Implementation | Gap/Limitation | Recommendation |
|---|---|---|---|
| 9.1.1 | Monitoring conducted regularly (air quality, odor, wastewater, emissions, water usage) supported by accredited laboratory | Monitoring is periodic but not continuous, and lacks integration into real-time decision systems | Implement continuous monitoring systems (online sensors, automated data logging) |
| 9.1.2 | Periodic compliance evaluation conducted, aligned with regulatory requirements and PROPER program | Compliance evaluation is checklist-based, not risk-based | Integrate risk-based compliance evaluation prioritizing high-impact regulations |
| 9.2 | Internal audits conducted periodically, managed by Management Representative, findings documented and followed up | Audit focuses on conformity, limited depth in performance evaluation and root cause analysis | Enhance audit scope to include root cause analysis and performance auditing |
| 9.3 | Annual management review conducted covering audit results, performance, | Review process is comprehensive but not strongly driven by | Strengthen management review with KPI dashboard (emission intensity, waste |

| Clause | Existing Implementation | Gap/Limitation | Recommendation |
|---|---|---|---|
| | stakeholder input, and improvements | quantitative performance indicators | reduction, resource efficiency) |

### 3.8 Analysis Based on Clause 10 of ISO 14001:2015 (Improvement)

Clause 10 of ISO 14001:2015 focuses on improvements. In Clause 10.1, the manufacturing industry defines nonconformity as any gap between field conditions and established procedures or plans. Such gaps are identified through internal audits and management reviews, and the company responds by improving product performance for future needs, reducing negative environmental impacts during production, and strengthening the effectiveness of the environmental management system.

In Clause 10.2, the company addresses nonconformities through both correction and corrective action. Corrections are immediate responses proportional to the impact and include identifying the cause, determining the action needed to prevent recurrence, implementing corrective steps, and documenting the results. Corrective actions are applied to prevent potential nonconformities by identifying possible causes, determining necessary preventive measures, ensuring implementation, maintaining records, and reviewing the effectiveness of these actions.

Clause 10.3 reflects the company's commitment to the continuous improvement of environmental performance. The manufacturing Industry performs continuous improvement actions documented in its Medium Term Environmental Conservation Implementation Plan 2025, which includes power-saving measures such as turning off lights during lunch, shutting laptops when unused, and reducing air conditioner use. Climate-related actions involve replacing diesel forklifts with electric models and applying timer controls to air conditioners. Water conservation efforts include recycling wastewater through reverse osmosis during production processes.

Compared to other ISO 14001:2015 studies, the manufacturing industry has a stronger integration between environmental management systems and actual practices. Previous studies have reported that many industries are still implementing ISO 14001:2015 to focus only on administrative compliance (Putra et al., 2024; Fauzi et al., 2025). However, the manufacturing industry has integrated environmental management into daily operational activities. Frontiers in Sustainability (2026) explained that organizations implementing ISO 14001:2015 with stronger integration can achieve better outcomes.

However, several gaps identified in this study indicate that the implementation of environmental management systems in the manufacturing industry is still somewhat compliance-oriented because organizations tend to prioritize certification over environmental performance and improvement (Hidayati et al., 2024). Similar challenges were identified by Harahap and Zakaria (2025), which are about communication effectiveness and environmental systems.

Inconsistent use of personal protective equipment in high-risk areas and outdated Material Safety Data Sheets are caused by communication systems that are mostly top-down. Coura et al. (2025) explained that employee awareness and competence can significantly affect the effectiveness of ISO 14001:2015 implementation. Therefore, future environmental management systems in manufacturing industries should focus on strengthening their performance through root cause analysis. The key findings and recommendations for the implementation of ISO 14001:2015 in Clause 10 are summarized in Table 7.

**Table 7.** Comparison of clause 10 requirements and their implementation

| Clause | Existing Implementation | Gap/Limitation | Recommendation |
|---|---|---|---|
| 10.1 | Improvement actions identified through audits, monitoring, and management review; programs include energy saving and resource efficiency | Improvement actions are mostly incremental and operational, not strategic or system-level | Develop structured improvement roadmap aligned with sustainability targets (energy, water, emission reduction) |

| Clause | Existing Implementation | Gap/Limitation | Recommendation |
|---|---|---|---|
| 10.2 | Nonconformities identified through audits and reviews; corrective actions implemented and documented | Root cause analysis not deeply applied, corrective actions tend to address symptoms rather than systemic causes | Apply structured root cause analysis methods (e.g., 5 Why, Fishbone Diagram) and verify effectiveness of corrective actions |
| 10.3 | Improvement programs implemented (energy saving, equipment replacement, water reuse via RO system) | Improvement initiatives exist but lack measurable performance indicators and benchmarking | Introduce KPI-based improvement evaluation (energy reduction %, water reuse %, emission reduction) |

## 4. Conclusion

Based on the observations, analysis, and discussion regarding the implementation of the ISO 14001:2015 Environmental Management System in the manufacturing industry, several conclusions can be drawn. The ISO 14001:2015 Environmental Management System in the manufacturing industry is integrated with other management systems, including the ISO 9001 Quality Management System and the Occupational Health and Safety Management System, as per Government Regulation No. 50 of 2012. The implementation of the environmental management system at the manufacturing industry has been well-executed and complies with the regulations and requirements outlined in ISO 14001:2015.

Environmental management in the manufacturing industry has been conducted according to the principles of ISO 14001:2015. For example, the manufacturing industry has its own Wastewater Treatment Plant (WWT) before discharging its effluent into the Industrial Estate's centralized IPAL, and all parameters meet the quality standards set by the estate. Hazardous and toxic waste is properly managed during storage and transportation and is regularly submitted to PROPER KLHK. However, challenges have been observed in the environmental management system in the manufacturing industry, including ineffective communication, employees not using personal protective equipment (PPE) in high-risk areas, and outdated Material Safety Data Sheets (MSDS).

This study provides a clause-based evaluation of ISO 14001:2015 and integrates it with the management system requirements. The novelty of this study lies in linking environmental performance practices with each ISO clause. This study highlights the importance of strengthening communication systems, enhancing employees' environmental awareness, and ensuring consistency in documentation updates. Future studies are recommended to explore the scope of ISO 14001:2015 and its integration with modern environmental management systems, such as real-time monitoring technologies.

## Acknowledgement

We would like to thank everyone involved in this research who contributed their time to its completion. The authors would also like to thank the Manufacturing Industry for their help and support. Special thanks to the entire team for their contribution to the completion of this study. We hope that this study will be useful for companies to improve their reputation and reduce production costs.

## Ethics Statement

This study did not involve any people, animals, or sensitive topics; therefore, no ethical approval was required.

## CRediT Author Statement

**Budi Prasetyo Samadikun**: Idea Development, Research Design, Supervision, Manuscript Review and Revision. **Himawan Aziz Muftiansyah**: Investigation, Formal Analysis, Data Curation, Visualization,

Manuscript Draft Preparation. **Nani Anggraini**: Supervision, Resources, Manuscript Review and Revision.

## References

Badan Standardisasi Nasional (BSN). 2015. SNI ISO 14001:2015 Sistem Manajemen Lingkungan – Persyaratan dengan Panduan Penggunaan. Jakarta: Badan Standardisasi Nasional.

Coura, F. 2025. Environmental awareness of employees in a frozen pre-fried potato industry based on ISO 14001:2015 implementation. Desafio Online. 1–15.

Fahmi, K. 2021. Effect of ISO 9001:2015, ISO 14001:2015 and ISO 45001:2018 on operational performance of automotive industries. Journal of Industrial Engineering and Management Research. 45–58.

Frontiers in Sustainability. 2026. Assessing ISO 14001:2015 implementation in Jordanian industry: An exploratory factor analysis of sustainability performance dimensions. Frontiers in Sustainability. 1–18.

Fauzi, A. 2025. Evaluation of the implementation of environmental management system based on ISO 14001:2015 at PT X, Batam City. KESANS: International Journal of Health and Science. 1–12.

Harahap, F., and Zakaria, M. 2025. The analysis of the implementation of EMS ISO 14001:2015 based on the Global Environmental Management Initiative at PT Pertamina Hulu Rokan Zone I Pangkalan Susu Field. Proceedings of the International Conference on Multidisciplinary Engineering (ICOMDEN). 1–10.

Hidayat, R. 2020. Penerapan ISO 14001 di Industri Manufaktur: Dampak pada Lingkungan dan Sosial. Jakarta: Gramedia.

Hidayati, R. N. 2024. Benefit analysis of environmental management system ISO 14001:2015 implementation in tyre manufacturing industry. Indonesian Journal of Applied Environmental Studies. 1–10.

Karuniasa, M. 2020. Effectiveness of ISO 14001:2015 implementation in small and medium enterprises (case study: A laundry machine industry SME in Bantul, Yogyakarta). IOP Conference Series: Earth and Environmental Science. 1–9.

Kuhre, W. L. 1995. ISO 14001 Environmental Management System Certification. New Jersey: Prentice Hall.

Maryeska, E., Pratama, A., and Wibowo, S. 2020. Penerapan Sistem Manajemen Lingkungan ISO 14001:2015 dalam Meningkatkan Kinerja Lingkungan Perusahaan. Bandung: Alfabeta.

Petroni, A. 2001. Developing a methodology for analysis of benefits and drawbacks of ISO 14001 registration: The case of a large Italian food machinery manufacturer. Business Strategy and the Environment. 10(6), 351–364.

Putra, Y. A. 2024. Implementation study of ISO 14001:2015 in the PT X textile industry. Sriwijaya Journal of Environment. 108–116.

Rahman, A. 2021. GAP Analysis Implementasi ISO 14000 pada PT. Citra Abadi Sejati. Jakarta: Erlangga.

Rizal, M., Suryanto, A., and Nugroho, R. 2016. Prinsip Penerapan dan Operasi Sistem Manajemen Lingkungan Berdasarkan ISO 14001:2004. Yogyakarta: Andi.

Song, D. 2024. Corporate environmentalism and economic performance: Examining the effects of ISO 14001 certification on technical efficiency. Environmental Science and Pollution Research. 1–23.

Sunu, P. 2001. Melindungi Lingkungan dengan Menerapkan ISO 14001. Jakarta: Prenhallindo.

Susilo, D. 2020. Strategi Pengelolaan Lingkungan Berkelanjutan pada Perusahaan Manufaktur. Surabaya: Airlangga University Press.

Testa, F. 2018. Adoption and Outcomes of ISO 14001: A Systematic Review. Journal of Cleaner Production.

United States Environmental Protection Agency (U.S. EPA). 2016. Environmental Management System (EMS): Implementation Guidelines for ISO 14001. Washington, DC: United States Environmental Protection Agency.

Whitelaw, K. 2004. ISO 14001 Environmental Management Systems Handbook. Oxford: Elsevier.