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Regional Case Study

Analysis of The Implementation of The ISO 14001:2015 Environmental Management System at Manufacture Industry

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Abstract

ISO 14001:2015 is an international standard issued by the International Organization for Standardization that regulates Environmental Management Systems (EMS) to help companies manage environmental impacts, comply with regulations, and achieve continuous improvement. Manufacture Industry, a foreign investment company engaged in diesel engine production, implements EMS as part of its commitment to environmental sustainability. This study evaluates the implementation of ISO 14001:2015 by comparing each clause of the standard with actual operational practices within the company. Data were collected through field observations and document reviews. The results show that Manufacture Industry has effectively implemented all clauses of ISO 14001:2015, particularly in waste management, air quality monitoring, and regulatory compliance. However, improvements are still needed in increasing employee awareness regarding the use of PPE in high-risk work areas. This study provides a more practical and structured approach to EMS evaluation by integrating clause-based ISO assessment with real industrial practices, which can serve as a reference for industries in improving EMS performance and operational control.

Keywords: Clause-Based Evaluation; continuous improvement; environmental management system; iso 14001:2015; operational control

1. Introduction

Throughout the year, environmental issues have always been a hot topic of discussion. Along with the development of the industrial world, environmental conditions will continue to change. The increasing human needs, driven by the growing population, lead to increased production activities by companies to meet those needs. As a result, environmental pollution levels are likely to rise. To prevent pollution, all parties must work together to ensure sustainable environmental preservation for future generations (Fahmi, 2021). The government, society, and environmental organizations need to 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 through the implementation of ISO (The International Organization for Standardization) standards (Maryeska et al., 2020). According to Hidayat (2020), ISO 14001 provides a framework for industry 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. ISO 14001 standard promotes a detail 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 a 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) examined the relationship between ISO 14001 certification and corporate environmental performance, while Testa (2018) reviewed the adoption and outcomes of ISO 14001 implementation across industries. However, most previous studies mainly emphasize general compliance evaluation and organizational performance, with limited discussion on the direct linkage between each ISO 14001:2015 clause and actual operational environmental practices in industrial facilities. Therefore, this study focuses on a clause-based implementation analysis to provide a more practical and operational evaluation framework.

Manufacture Industry, one of the largest diesel engine manufacturers in Indonesia, is an example of a company facing various potential environmental pollution from its production activities. The production of diesel engines by Manufacture Industry has a high potential to generate hazardous liquid waste and air pollution resulting from various production processes, including machining, painting, and assembling. Manufacture Industry strives to maintain the high quality of its diesel engine products while minimizing risks to the environment and the surrounding community.

Observations were made at Manufacture Industry located in the Bukit Semarang Baru (BSB) Industrial Area, where the company has been ISO 14001:2015 certified since 2006 by Lloyd's Register (UK). This certification supports the implementation of hazard control programs, such as monitoring ambient air quality and odor analysis, testing liquid waste, analyzing emissions from stationary sources, testing RO drinking water quality, monitoring clean water usage, analyzing domestic wastewater, and analyzing emissions from mobile sources. All monitoring and measurement activities have been routinely carried out in accordance with applicable regulations. Manufacture 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. Manufacture 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 Manufacture 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 ISO 14001:2015 implementation in industrial sectors, mainly focusing on certification benefits, environmental compliance, and general environmental performance. However, limited studies specifically evaluate 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 at Manufacture Industry by linking standard requirements with real environmental management practices in the company.

In maintaining the sustainability of the environmental management system at Manufacture 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 has been carried out 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 aims to analyze the implementation of ISO 14001:2015 at Manufacture Industry using a clause-by-clause evaluation approach (Clause 4 to Clause 10) to identify the level of compliance, existing gaps, and areas for improvement. The scope of this research is limited to environmental management practices within the main operational facility, focusing on system implementation, operational control, environmental monitoring, and continuous improvement mechanisms. The unique contribution of this study lies in providing a structured linkage between ISO requirements and real industrial practices, offering a more practical and applicable evaluation framework for environmental management systems.

2. Methods

This research was conducted at Manufacture Industry, located at Jl. Taman Industri Bukit Semarang Baru, Mijen District, Semarang City, Central Java. The observation lasted for 23 working days, starting from January 6, 2025, to February 7, 2025. The research began with the preparation phase, followed by the implementation phase, and concluded with analyze and report writing phase.

The data collection method was carried out in two ways: primary data collection and secondary data collection. Primary data collection was done through direct observation during the research. Secondary data collection was conducted by gathering data from previous reports and research journals, as well as data obtained from the company.

The analytical approach was conducted using a systematic clause-by-clause comparison (Clause 4 to Clause 10), where each ISO 14001:2015 requirement was evaluated against actual implementation in the company. In addition, the evaluation process follows a logical flow that can be described as: identification of ISO requirements → mapping of existing company practices → gap identification → formulation of improvement recommendations.

3. Result and Discussion

3.1 ISO 14001:2015 Profile at Manufacture Industry

Manufacture 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 the organization in managing environmental impacts. Mapping is conducted to identify obstacles in the environmental management system so that improvements can be made promptly. 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 and influential on the organization. Stakeholders are those that 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 Manufacture Industry builds its environmental management foundation. The first part is clause 4.1 Understanding the Organization and its Context, which requires the company to identify internal issues and external issues that influence its operations, strategic direction, and ability to achieve intended outcomes. Manufacture 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 employees where some workers still ignore proper personal protective equipment which exposes them to chemical risks that may affect skin and eyes. External issues include ongoing changes in environmental regulations that require rapid adjustment of practices and procedures. Competitive pressure from other tractor manufacturers that can reach remote regions outside Java more effectively is also an important external factor that affects the company's standing in the market.

The next part is clause 4.2 Understanding the Needs and Expectations of Interested Parties. This clause requires organizations to understand the needs and expectations of interested parties relevant to the environmental management system (Rahman, 2021). Manufacture Industry determines which stakeholders have interests in or may be affected by its environmental performance and then identifies what each stakeholder expects. Management reviews these expectations to decide which of them become binding obligations for the company. Directors expect sustainable profit supported by efficient operations and controlled risks. Auditors expect full compliance with ISO 9001:2015, ISO 14001:2015, and Occupational Health and Safety Management System based on Government Regulation Number 50 of 2012 through complete documentation and consistent implementation. Industrial associations expect active participation and adherence to sector guidelines. Financial institutions expect stable financial performance and timely payments. Shareholders expect consistent dividends and transparent reporting. Customers expect products that are safe and reliable with responsive service. Employees expect a workplace that supports safety, wellbeing, and fair employment conditions. Suppliers expect fair cooperation and smooth payment processes. Government authorities expect legal compliance regarding environmental protection, waste management, and taxation. Communities around the facility expect the company to prevent pollution and contribute to local environmental quality through responsible operations and appropriate social programs.

The clause continues with clause 4.3 Determining the Scope of the Environmental Management System. Manufacture Industry defines the boundaries of its environmental management system by limiting the certification scope to the head office facility located in Taman Industri Bukit Semarang Baru, Mijen, Semarang. Representative offices outside the head office are excluded from the ISO 14001:2015 scope. The defined scope covers all environmental aspects and activities in the head office area including wastewater treatment, temporary waste storage, production areas, vehicle operations, and the training center.

The final part is clause 4.4 Environmental Management System. Manufacture Industry 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 that 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 long term commitment to

structured environmental management. The key findings and recommendations of the 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 5.1 Leadership and Commitment. Top management needs to improved environmental management, clearly defined goals, responsibilities and accountabilities, creates a greater awareness and understanding of environmental issues and an improved corporate culture (Petroni, 2001). Top management at Manufacture Industry holds full responsibility for establishing, implementing, and maintaining the environmental policy 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 Government Regulation Number 50 of 2012. Leadership commitment is shown through several actions that include setting and communicating company policies, establishing the 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.

The clause continues with clause 5.2 Environmental Policy, which requires top management to define an environmental policy consistent with the organization's purpose and direction. At Manufacture Industry, the environmental policy has been established directly by the president director under the title Quality and Environmental Policy. This policy forms the foundation for the company's environmental management system and aligns with ISO 9001:2015 and ISO 14001:2015 requirements. As a leading manufacturer of internal combustion engines in Indonesia, the company commits to producing high quality

products that contribute to national economic growth while also enhancing environmental protection performance. The commitment is reflected in several principles such as 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 openly across the organization and made available to external parties so it can function as a guiding reference for all activities related to quality and environmental management.

Another component of Clause 5 is cause 5.3 Organizational Roles, Responsibilities, and Authorities. Top management must ensure that relevant roles, responsibilities, and authorities are defined, communicated, and implemented throughout the organization. Manufacture 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 Number 50 of 2012. The key findings and recommendations of the ISO 14001:2015 implementation 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 Manufacture Industry develops, applies, and maintains the processes needed to fulfill all planning requirements. The company evaluates internal factors and external conditions that influence strategic direction and operational control, ensuring that actions remain aligned with the expectations of interested parties and with the established scope of the environmental management system.

This planning requirement continues to clause 6.1.2 Environmental Aspects. Sunu (2001) explains that effective environmental management requires companies to develop and maintain written procedures to identify environmental aspects arising from controllable activities, products, or services with the potential for significant environmental impact. Manufacture Industry must identify environmental aspects arising from its activities under normal conditions, abnormal situations, and emergency scenarios.

Workplace design, process layout, machinery, operational procedures, and organizational structure are examined alongside findings from corrective actions, preventive actions, and incident investigations. The HIRADC method is applied to identify hazards, evaluate the likelihood and consequences of each potential impact, and determine the appropriate controls based on the hierarchy of risk reduction. All environmental aspects are recorded in the ASDAM document which uses a severity probability control evaluation to determine which aspects are significant and require higher priority in environmental programs.

The clause develops further into clause 6.1.3 Compliance Obligations. Kuhre (1995) states that organizations must identify all applicable regulations related to their operational activities, encompassing regulatory frameworks at the international, federal, state, regional, and local level, which requires Manufacture Industry to identify and consider all legal and regulatory requirements relevant to the activities covered by the environmental management system. After identifying environmental aspects, the company reviews national laws, government regulations, regional regulations, and directives from authorized agencies to determine which obligations apply.

After environmental aspects and compliance obligations have been identified, the planning sequence continues into clause 6.1.4 Planning Action, where Manufacture Industry determines the actions needed to address significant aspects, legal obligations, risks, and opportunities. The company reviews information from HIRADC and ASDAM, particularly the severity, probability, and control analysis results that determine whether an aspect is considered significant. Based on these evaluations, the organization develops appropriate control measures or utilization strategies for each aspect.

Clause 6 then moves into the formulation of targets through clause 6.2.1 Environmental Objectives, which require Manufacture Industry to define objectives that reflect the environmental policy and the company's commitment to continual improvement. These objectives must be measurable, monitored, communicated, and updated regularly. The company establishes its long term vision, mission, goals, targets, and environmental programs based on the integration of system requirements, the results of environmental aspect identification, environmental risk evaluations, and the review of legal and other requirements. Any planned change related to environmental objectives is carried out thoughtfully by considering the purpose of the change and its potential impacts, the availability of resources, and the clarity of assigned responsibilities and authorities. All objectives and targets must be measurable, properly documented, and supported by continuous monitoring and evaluation to ensure they remain achievable and relevant.

The clause then extends into clause 6.2.2 Planning to Achieve Environmental Objectives, which describes how Manufacture Industry organizes its environmental management actions to meet the targets that have been set. Since production activities generate several types of waste with potential environmental impacts, the company develops comprehensive waste management plans that cover solid waste, wastewater, and hazardous waste. Solid waste management addresses both domestic waste and production waste. Domestic waste such as food residues is separated into categories like plastic, paper, and waste containing hazardous elements, and stored in designated containers before being transferred to the temporary storage area and collected by the industrial estate operator. Production related solid waste such as cardboard is collected and handed over to a licensed recycler.

Wastewater management follows a multistage process that begins with pre treatment. Wastewater from assembling that does not contain oil is pumped into the chemical treatment unit, while oily wastewater is routed through an oil separator tank before being transferred to the same treatment unit. Wastewater from machining goes through its holding tank, then the oil separator, and finally the chemical unit. Wastewater from painting follows a similar route. The separated oil is collected manually, stored in sealed drums, and placed in the hazardous waste storage area. All wastewater streams that finish pre treatment are mixed in the chemical treatment section, where pH adjustment, coagulation, and flocculation

steps take place using reagents such as calcium hydroxide, sulfuric acid, and coagulating polymers. The resulting floc is settled in a clarifier before the treated water is transferred to the domestic wastewater tank and mixed with wastewater from bathrooms, sinks, and office facilities. The combined wastewater then enters the biological treatment system consisting of nitrification, denitrification, and transfer stages inside the MBR unit. Sludge generated during the process is moved into a slurry tank and later dewatered in a dehydrator before drying. The final treated water passes through an activated carbon filtration tank before entering the effluent tank. A portion of this treated water is reused in the production process, specifically for paint booth dust capture systems, while the remainder is discharged to the wastewater treatment system of the industrial estate.

Management of hazardous waste includes items such as used batteries, metallic sludge, paint sludge, used ink containers, wastewater treatment sludge, used filters, spent lubricants, electronic waste including lamps, used chemical containers, contaminated cleaning cloths, toner waste, and clinical waste. These materials are segregated, logged in a waste book, and stored in the hazardous waste facility for no longer than the maximum permitted period. After that, 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 of the ISO 14001:2015 implementation 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)
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	Strong operational system, but limited performance evaluation metrics and	Introduce performance monitoring (BOD/COD removal efficiency, water

Clause	Existing Implementation	Gap/Limitation	Recommendation
	waste) including WWTP processes	optimization analysis	reuse %, waste recovery rate)

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

Clause 7 explains the support elements required to operate the environmental management system effectively. Clause 7.1 Resources 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 continues to improve. Proper placement of employees based on their competence and capacity allows work to be performed efficiently.

Clause 7.2 Competence explains the company's commitment to involving employees in training and capacity building related to environmental management and this competence 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 daily work. Manufacture 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 operations.

Clause 7.3 Awareness 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. Manufacture 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 carried out to raise awareness, such as morning checks, safety flashes, Kiken Yochi Training, the Five Genba Principles, the Safety Man and Safety Dojo activities, the Safety Board, the XXX Environmentally Friendly Human Guidelines, basic training, and the Stop, call, and wait instruction.

Clause 7.4.1 General Communication requires the company 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 continual improvement. Manufacture Industry conducts internal and external communication as part of this requirement. Clause 7.4.2 Internal Communication follow 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 carried out 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 General Documented Information ensures that information is accessible and traceable. Manufacture Industry evaluates the form of documentation by considering document availability, storage format, authorized personnel for approval and revision, and document identification systems. Documentation is structured into several levels. The first level consists of the manual and the Global XXX Standard, which serve 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 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 documents.

Clause 7.5.2 Creating and Updating Documented Information 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 the 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 Control of Documented Information. Manufacture 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. Current versions must be available at all relevant locations. Outdated documents must be removed or clearly identified to prevent unintended use. The key findings and recommendations of the 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
7.4.3	Public information via website and social media, interaction with customers	External communication focuses on information delivery, not stakeholder	Integrate stakeholder feedback system into EMS evaluation process

Clause	Existing Implementation	Gap/Limitation	Recommendation
	and stakeholders	engagement evaluation	
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 operation. Clause 8.1 Operational Planning and Control involve activities that 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). Manufacture Industry manages environmental impacts by identifying significant environmental aspects and planning controls that align with policy, 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 upheld. Suitable equipment is selected to keep maintenance activities consistent with 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 Emergency Preparedness and Response, which requires the company to anticipate and manage potential emergency situations that may threaten employee safety, the community, or the environment. Manufacture Industry maintains evacuation routes, fire extinguishers, hydrants, emergency eye wash stations, and other safety equipment across the facility to support rapid response. Clear responsibilities are established. The Occupational Safety and Health Advisory Committee appoints the emergency response team. The team leader coordinates actions and reports to the comittee, while the Human Resorces 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, poisoning, or natural disasters. The key findings and recommendations of the 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 operational performance to determine 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. In clause 9.1.1 General Monitoring Measurement Analysis and Evaluation, Manufacture Industry conducts scheduled monitoring of activities with significant environmental impact. The company follows the Environmental Management Plan and Environmental Monitoring Plan and carries out regular assessments of ambient air quality, odor, wastewater quality, stationary and mobile emissions, RO drinking water, clean water consumption, and domestic wastewater. These measurements are supported by the accredited laboratory PT Syslab, and key parameters such as ambient air and odor are monitored every six months to ensure consistent environmental performance.

In clause 9.1.2 Evaluation of Compliance, the company performs periodic reviews of legal and other applicable requirements to confirm that all obligations are met. This evaluation also supports participation in the national PROPER program, which involves monitoring and verification by the Ministry of Environment and Forestry regarding environmental permits, water and air pollution control, and hazardous waste management.

Clause 9.2 Internal audits are recognized as an essential improvement mechanism in management systems. For environmental management systems, internal audits are required to verify conformity with ISO 14001 requirements and internal organizational procedures. Internal auditors review operations and system implementation based on documented procedures and environmental objectives. (Whitelaw, 2004). The management representative oversees the audit program to ensure full coverage, competent auditors, proper communication of findings, verification of corrective actions, and complete documentation. The audit cycle includes planning, defining scope and methods, assigning auditors, conducting the audit independently, and reporting results for corrective action by responsible units.

Clause 9.3 Management review requires evaluation of the environmental management system at least once a year. At Manufacture Industry the president director leads this review to assess system suitability, effectiveness, achievement of objectives, and the need for improvement. The agenda also covers follow up from previous reviews, audit results, stakeholder feedback, process and environmental performance, the status of corrective actions, and organizational or regulatory changes that may affect the system. The key findings and recommendations of the 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	Compliance evaluation is checklist-based, not risk-based	Integrate risk-based compliance evaluation prioritizing high-impact

Clause	Existing Implementation	Gap/Limitation	Recommendation
	and PROPER program		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, stakeholder input, and improvements	Review process is comprehensive but not strongly driven by quantitative performance indicators	Strengthen management review with KPI dashboard (emission intensity, waste reduction, resource efficiency)

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

Clause 10 of ISO 14001:2015 focuses on improvement. In clause 10.1 General Improvement, Manufacture 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 in production, and strengthening the effectiveness of the environmental management system.

In clause 10.2 Nonconformity and Corrective Action, 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 the corrective step, 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 measures.

Clause 10.3 Continual Improvement reflects the company's commitment to ongoing enhancement of environmental performance and system effectiveness. Manufacture Industry implements continual improvement actions documented in its Medium Term Environmental Conservation Implementation Plan 2025. These include 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 for production processes.

Compared with other ISO 14001:2015 implementation studies, Manufacture Industry demonstrates relatively stronger operational integration between environmental management system requirements and actual environmental control practices. Previous studies reported that many manufacturing industries implementing ISO 14001:2015 still focus mainly on administrative compliance, documentation fulfillment, and certification maintenance, while environmental performance measurement and operational integration remain limited (Putra et al., 2024; Fauzi et al., 2025). In contrast, Manufacture Industry has integrated environmental management activities directly into operational processes such as wastewater treatment, hazardous waste segregation and storage, ambient air and emission monitoring, environmental monitoring programs, and water reuse through reverse osmosis systems.

The implementation of wastewater treatment processes at Manufacture Industry contributes to maintaining effluent quality before discharge into the centralized industrial estate wastewater treatment system, while hazardous waste management activities including segregation, storage, documentation, and transportation by licensed third parties support pollution prevention and regulatory compliance objectives. In addition, periodic ambient air monitoring, stationary and mobile emission monitoring, and odor analysis contribute to environmental compliance evaluation and continuous environmental performance

monitoring. Similar findings were reported by Frontiers in Sustainability (2026), which stated that organizations implementing ISO 14001:2015 with stronger operational environmental integration generally achieved better environmental outcomes, particularly in pollution prevention, waste reduction, resource efficiency, and sustainability performance.

However, several gaps identified in this study indicate that the environmental management system implementation at Manufacture Industry remains partially compliance-oriented rather than fully performance-oriented. This condition commonly occurs because organizations tend to prioritize certification conformity and audit readiness over quantitative environmental performance evaluation and strategic sustainability improvement (Hidayati et al., 2024). Corrective actions that are not yet fully supported by structured root cause analysis may reduce the effectiveness of continual improvement processes and delay early identification of environmental risks. Similar operational and organizational challenges were also identified by Harahap and Zakaria (2025), particularly regarding communication effectiveness, competency strengthening, and operational environmental support systems.

Employee environmental behavior also remains an important factor influencing environmental management system effectiveness. The inconsistent use of personal protective equipment in high-risk areas and outdated Material Safety Data Sheets identified in several operational locations may result from insufficient behavioral enforcement, limited awareness effectiveness evaluation, and communication systems that remain predominantly top-down. Coura et al. (2025) emphasized that employee environmental awareness and competence significantly affect the effectiveness of ISO 14001:2015 implementation because employees directly influence daily operational environmental control. Weak environmental awareness may increase the risk of improper hazardous waste handling, chemical exposure, operational nonconformities, and environmental safety incidents. Therefore, future environmental management system improvement at Manufacture Industry should focus not only on maintaining conformity with ISO 14001:2015 requirements but also on strengthening performance-based environmental governance through structured root cause analysis and behavior-based environmental programs.

The key findings and recommendations of the ISO 14001:2015 implementation 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)
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 at Manufacture Industry, several conclusions can be drawn. The ISO 14001:2015 Environmental Management System at Manufacture 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 Manufacture Industry has been well-executed and complies with the regulations and requirements outlined in ISO 14001:2015.

Environmental management at Manufacture Industry has been conducted according to the principles of ISO 14001:2015. For example, Manufacture Industry has its own Wastewater Treatment Plant (WWT) before discharging its effluent into the Industrial Estate's centralized IPAL, and all parameters have met the quality standards set by the estate. Furthermore, the management of hazardous and toxic waste has been conducted properly in terms of storage and transportation, with detailed documentation maintained in the logbook and waste balance sheet, which are regularly submitted to the Ministry of Environment and Forestry website.

However, there are some challenges observed in the environmental management system at Manufacture Industry. These include ineffective communication between departments leading to miscommunication, some employees still not using personal protective equipment (PPE) in high-risk areas, and the need to replace some faded Material Safety Data Sheets (MSDS) in The Wastewater Treatment Plan Area.

This study contributes by providing a comprehensive clause-based evaluation of ISO 14001:2015 implementation in a real industrial setting, integrating technical operational practices with management system requirements. The novelty lies in linking environmental performance practices such as wastewater treatment, hazardous waste management, and monitoring systems directly with each ISO clause, allowing a more structured and practical assessment approach rather than purely theoretical compliance evaluation.

From a practical perspective, this study highlights the importance of strengthening internal communication systems, enhancing employee environmental awareness through continuous training and enforcement mechanisms, and ensuring the consistency of documentation updates as part of operational control. Companies implementing ISO 14001:2015 are recommended to adopt more measurable performance indicators, improve cross-departmental coordination, and integrate digital monitoring systems to enhance environmental performance tracking and decision-making efficiency.

For future research, further studies are recommended to explore the scalability of ISO 14001:2015 implementation across multiple operational sites and its integration with emerging smart environmental management systems, including real-time monitoring technologies and smart city platforms. Additionally, future work can focus on incorporating quantitative performance analysis such as environmental efficiency metrics, carbon footprint assessment, and life cycle analysis to strengthen the evaluation of environmental management systems beyond compliance-based approaches.

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Ethics Statement

This study did not involve human participants, animals, or sensitive data; 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

BSN. (2015). *SNI ISO 14001:2015 Sistem Manajemen Lingkungan – Persyaratan dengan Panduan Penggunaan*. Jakarta: Badan Standardisasi Nasional, pp. 1–44.

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

Fahmi, K. (2021). *Effect of ISO 9001:2015, ISO 14001:2015 and ISO 45001:2018 on operational performance of automotive industries*. Jakarta: JIEMAR, pp. 45–58.

Frontiers in Sustainability. (2026). *Assessing ISO 14001:2015 implementation in Jordanian industry: an exploratory factor analysis of sustainability performance dimensions*. Lausanne: Frontiers in Sustainability, pp. 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, pp. 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 International Conference on Multidisciplinary Engineering (ICOMDEN), pp. 1–10.

Hidayat, Rachmat. (2020). *Penerapan ISO 14001 di Industri Manufaktur: Dampak pada Lingkungan dan Sosial*. Jakarta: Gramedia, pp. 1–215.

Hidayati, R.N. (2024). *Benefit analysis of environmental management system ISO 14001:2015 implementation in tyre manufacturing industry*. Indonesian Journal of Applied Environmental Studies, pp. 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)*. Bristol: IOP Publishing, pp. 1–9.

Kuhre, W. L. (1995). *ISO 14001 Environmental Management System Certification*. New Jersey: Prentice Hall, pp. 1–320.

Maryeska, E., Pratama, A., & Wibowo, S. (2020). *Penerapan Sistem Manajemen Lingkungan ISO 14001:2015 dalam Meningkatkan Kinerja Lingkungan Perusahaan.* Bandung: Alfabeta, pp. 1–187.

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*. London: Elsevier, pp. 351-364.

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

Rahman, A. (2021). *GAP Analysis Implementasi ISO 14000 pada PT. Citra Abadi Sejati*. Jakarta: Erlangga, pp. 1–156.

Rizal, M., Suryanto, A., & Nugroho, R. (2016). *Prinsip Penerapan dan Operasi Sistem Manajemen Lingkungan Berdasarkan ISO 14001:2004.* Yogyakarta: Andi Publisher, pp. 1–192.

Song, D. (2024). *Corporate environmentalism and economic performance: Examining the effects of ISO 14001 certification on technical efficiency*. New York: Springer, pp. 1–23.

Sunu, P. (2001). *Melindungi Lingkungan dengan Menerapkan ISO 14001*. Jakarta: Prenhallindo, pp. 1–228.

Susilo, D. (2020). *Strategi Pengelolaan Lingkungan Berkelanjutan pada Perusahaan Manufaktur.* Surabaya: Airlangga University Press, pp. 1–228.

Testa, F. (2018). *Adoption and Outcomes of ISO 14001: A Systematic Review*. Oxford: Elsevier.

United Stated Environmental Protection Agency. (2016). *Environmental Management System (EMS): Implementation Guidelines for ISO 14001.* Washington DC: US EPA, pp. 1–87.

Whitelaw, K. (2004). *ISO 14001 Environmental System Handbook*. Oxford: Elsevier, pp. 1–576.