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Analysis of the implementation of the ISO 14001 environmental management system in a concrete manufacturing plant

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Abstract

Background: One of the main efforts in promoting sustainability is the implementation of ISO 14001, an international standard for Environmental Management Systems (EMS). In addition to helping companies comply with environmental regulations and reduce the risk of legal sanctions, ISO 14001 also contributes to improving operational efficiency, reducing costs, and achieving business sustainability. Effective implementation not only supports environmental preservation but also creates healthier and more productive working conditions.

Purpose: To analyze the implementation of the ISO 14001 environmental management system in a concrete production plant.

Method: Descriptive observational research with a qualitative approach using a cross-sectional design. This research was conducted at a concrete production company in Demak City, namely PT Varia Usaha Beton Plant Sayung, which has been operating since 1991 and employs 59 workers. The researcher determined the main informant as the subject of this research, namely the manager who is directly responsible for the implementation of ISO 14001 and workers from the quality control section, while for the triangulation informant the researcher chose the Factory Head. ISO 14001 contains 10 clauses, but the researcher only used six clauses with a checklist to assess the implementation of ISO 14001, including organizational context, leadership, planning, support, operations, performance evaluation, and continuous improvement.

Results: The implementation of ISO 14001 is in accordance with the standard of 87.2%. Around 71.1% of respondents have a smoking habit which is a major concern in the context of occupational health. This habit can increase the prevalence of health problems such as shortness of breath and flu/prolonged cough observed in some respondents. As many as 20.3% of respondents experienced shortness of breath while working, and 76.2% experienced flu or cough for more than a week. These figures are quite high and may indicate exposure to dust, air pollution, or poor ventilation in the workplace. Most respondents had no history of illness (83.1%), but the high prevalence of respiratory symptoms indicates the need for an environmental evaluation in the workplace. The results of dust measurements also showed that there were areas where the threshold value was exceeded.

Conclusion: Although the company has taken positive steps in implementing an environmental management system, controlling dust and enhancing protection for workers remains a critical focus to prevent occupational diseases that are still occurring.

Suggestion: To improve the effectiveness of the Environmental Management System (EMS), organizations need to strengthen operational control and communication with external suppliers to ensure that all processes and business partners meet the established environmental standards. In addition, emergency preparedness should be improved through regular evaluation of emergency response procedures, so that responses to critical situations can be faster and more effective.

Keywords: Concrete Manufacturing Plant; Environmental Management; ISO 14001.

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INTRODUCTION

Since the Stockholm Environment Conference in 1972 and the Earth Summit in 1992, the environment has remained a top priority on the international agenda. Following the World Summit on Sustainable Development (WSSD) in 2002, positive progress was achieved, leading to the establishment of various environmental management mechanisms formulated to address specific environmental issues (Susanto & Mulyono, 2018). In recent years, an increasing number of international and local industry players have adopted various types of Environmental Management Systems (EMS) to identify and manage the impacts of commercial, industrial, and service operations on the environment. Environmental management has become a central issue on corporate agendas due to growing concerns about the impact of their activities on natural resources (Mahzun, Thamrin, Bahrudin, & Nofrizal, 2020). Several recognized environmental management standards have been developed to help companies reduce their negative impact on the environment. One of the most renowned is ISO 14001, a process-based standard that provides guidance to companies in implementing an Environmental Management System (EMS). In addition to continuous improvement as a core principle of ISO 14001, ISO 14001:2015 outlines several major changes, including structural changes and substantive changes such as enhanced leadership accountability; lifecycle approach; rethinking impacts; risks and opportunities; proactive reporting; and strengthened compliance (Muzanni, Soesilo, Martono, Hamzah, Berkademi, & Febraldo, 2022).

Given the complexity and broad scope of environmental issues in the energy industry, the government's strict regulatory approach has encountered several limitations, including inflexibility to realities on the ground, reactive rather than proactive initiatives, an overly burdensome approach, and cost inefficiencies, among others (Sam & Song, 2022). In this regard, the government has promoted a more self-regulatory approach in the Environmental Management System (EMS) to accelerate the paradigm shift in environmental management and sustainability. The government recognizes the various benefits offered by the ISO 14001 EMS as a regulatory mechanism to ensure environmental sustainability in the industry. As of 2019, based on

data from the Central Statistics Agency, the number of companies in Indonesia that have implemented ISO 14001 as an Environmental Management System has reached 2,125 companies (Munandar, Khoriyah, & Aprilasani, 2021).

Construction companies are among those that have significantly expanded in major cities. Unfortunately, construction activities often consume substantial natural resources and, in many cases, result in severe environmental pollution, such as water, waste, and air pollution (Tanaya & Panjaitan, 2015). To address these issues, a specialized standardization system is necessary. The ISO 14001 standard is an international standard system focused on waste management systems and environmental management assessments (Johnstone & Hallberg, 2020). In this context, the implementation of ISO 14001, an international standard for Environmental Management Systems (EMS), has become a crucial step in shaping sustainable and responsible business practices (Helmina, Sutomo, & Respati, 2022).

As the industry evolves and public awareness of environmental issues increases, concrete companies are under growing pressure to manage the environmental impacts of their operations. With the use of large amounts of raw materials, high energy consumption, and significant waste production, the concrete industry has a potentially substantial ecological impact. Concrete companies often have to deal with strict environmental regulations (Ika, Okfitasari, & Widagdo, 2022). ISO 14001 helps ensure that companies understand and comply with applicable legal and regulatory requirements, reducing the risk of legal sanctions and providing a foundation for conducting operations in compliance with regulatory standards (Yoshana, Putra, & Ulina, 2021). The implementation of ISO 14001 is not only related to legal obligations and customer demands but also to increased efficiency and productivity. Environmental Management Systems help companies identify areas where efficiency can be improved, including resource usage and waste reduction, which, in turn, can lower operational costs (Mosgaard, Bundgaard, & Kristensen, 2022).

ISO 14001 helps ensure that companies understand and comply with applicable legal and regulatory requirements, reducing the risk of legal sanctions and providing a foundation for operating in

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accordance with regulatory standards (Budi, Karuniasa, & Nurcahyo, 2020). The implementation of ISO 14001 is not only related to legal obligations and customer demands but also to improvements in efficiency and productivity (Hidayati, Sodikin, & Nurhasanah, 2023). Environmental Management Systems help companies identify areas where efficiency can be improved, including resource use and waste reduction, which in turn can lower operational costs (Syam, Arianti, Rismaningsih, & Khamaludin, 2021). Concrete production may be associated with the risk of lung diseases among workers due to several factors, primarily related to dust generated during the concrete production process. Some materials used in concrete production, such as cement and stone powder, can produce dust containing fine particles that pollute the air. Repeated and high-volume inhalation of this dust can increase the risk of lung diseases among workers (Panya, Poboon, Phoochinda, & Teungfung, 2018). Conditions that may be associated with respiratory disorders in concrete plants include pneumoconiosis or dust-related lung diseases, chronic bronchitis, occupational asthma, hypersensitivity pneumonitis, and upper respiratory tract infections (Park, Zoh, Jeong, Koh, Lee, Lee, & Ha, 2024). Although ISO 14001 is not directly related to worker health, the implementation of this standard can positively impact working conditions and ultimately help reduce the risk of occupational diseases (Atik, 2019).

The implementation of ISO 14001 encourages organizations to identify and evaluate the environmental impacts of their operational activities. This process can include identifying hazardous substances or production processes that have the potential to cause occupational diseases. ISO 14001 also encourages companies to manage hazardous materials in safer and more sustainable ways. Improved management practices can reduce worker exposure to hazardous substances, thereby lowering the risk of disease (Autenrieth, Brazile, Sandfort, Douphrate, Román-Muñoz, & Reynolds, 2016). To achieve better sustainability, companies should consider ISO 14001 as an essential tool to guide their efforts toward more environmentally friendly and

sustainable business practices (Bilafiqri, 2023). This implementation not only provides benefits at the operational level but also lays a foundation for sustainable and responsible business growth. Through the integration of this environmental management system, ISO 14001 helps organizations reduce the risk of environmental pollution and mitigate potential health impacts. Effective implementation can ensure that organizations adhere to the highest standards in maintaining the safety and health of surrounding communities while contributing to environmental conservation (Hendrawati, Cahyono, & Purba, 2023).

RESEARCH METHOD

Descriptive observational research with a qualitative approach using a cross-sectional design. This research was conducted at a concrete production company in Demak City, namely PT Varia Usaha Beton Plant Sayung, which has been operating since 1991 and employs 59 workers. This company focuses on the production and distribution of various types of high-quality concrete products. In addition, it has been ISO 14001 certified by MSECBC, a Canadian audit firm in June 2022 and is valid until June 2025.

The researcher determined the main informant as the subject of this research, namely the manager who is directly responsible for the implementation of ISO 14001 and workers from the quality control section, while for the triangulation informant the researcher chose the Factory Head. The research instrument used was a questionnaire sheet and data was obtained through an interview process with informants. ISO 14001 contains 10 clauses, but the researcher only used six clauses with a checklist to assess the implementation of ISO 14001, including organizational context, leadership, planning, support, operations, performance evaluation, and continuous improvement. Researchers also measured dust levels using a spirometer to determine whether dust in the work environment was still within normal limits. This study has obtained ethical permission from PT Varia Usaha Beton Plant Sayung with the number: 0246 / KP.00.01 / 11100 / 01.2024, on January 5, 2024.

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RESEARCH RESULTS**Table 1. Distribution of Respondent Characteristics (N=59)**

Variables	Results
Age (n/%) (Mean±SD)(Range)(Years)	(30.013±1.546)(21-55)
≥30	24/40.6
<30	35/59.4
Gender (n/%)	
Female	12/20.3
Male	47/79.7
Length of Service (n/%) (Years)	
≥5	27/45.7
<5	32/44.3
Smoking Habit (n/%)	
Yes	42/71.1
No	17/28.9
Personal Protective Equipment Completeness (n/%)	
Yes	26/44.0
No	33/56.0
Medical History (n/%)	
Present	10/16.9
Absent	49/83.1
Physical Injury at Work (n/%)	
Experienced	3/5.1
Not Experienced	56/94.9
Shortness of Breath During Work (n/%)	
Experienced	12/20.3
Not Experienced	47/79.7
Flu/Cough Lasting More Than 1 Week (n/%)	
Experienced	45/76.2
Not Experienced	14/23.8

The majority of workers were under 30 years old (35) (59.4%), indicating that the workplace is dominated by a younger workforce. Most respondents were male (79.7%) and had less than five years of service (54.3%). A total of 71.1% of respondents reported smoking habits, which is a significant issue in the context of occupational health. This habit can increase the prevalence of health problems such as shortness of breath and flu or prolonged cough, which were reported by several respondents. Around 20.3% of respondents experienced shortness of breath while working, and 76.2% experienced flu or cough symptoms that lasted more than a week. These high numbers may indicate exposure to dust, air pollution, or inadequate ventilation in the workplace. Although most respondents had no history of medical illness (83.1%), the high prevalence of respiratory symptoms highlights the need for an evaluation of the work environment.

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Only 44% of workers reported using complete Personal Protective Equipment (PPE). However, the use of PPE is an important component in preventing workplace accidents and protecting workers from environmental hazards. The lack of complete use of PPE can stem from inadequate availability, lack of awareness, or undisciplined work habits. This low level of PPE use requires special attention, especially since 5.1% of respondents experienced physical injuries while working.

Table 2. Percentage of ISO 14001 Implementation Success

Variables	Percentage (%)
Context of the Organization	94.7
Leadership	85.0
Planning	90.6
Support	82.8
Operations	66.6
Performance Evaluation	91.3
Continual Improvement	100.0

Table 2. illustrates the level of achievement of the organization in various aspects, ranging from understanding the organizational context to commitment to continuous improvement. This data provides valuable insights to understand the strengths and areas that need improvement in the organization. The company consistently understands its context, identifies relevant internal and external issues, understands the needs and expectations of stakeholders, defines the appropriate EMS scope, and continuously improves the EMS to achieve the desired environmental goals. Based on the interview results, for the Leadership variable, the company has not developed a framework in its EMS documentation, which is why the percentage obtained is only 85%. For the Planning variable, there has been no consideration of the life cycle related to environmental aspects. The company has also not considered alternative technology options to manage environmental aspects.

For the Support variable, the company does not have documentation on the competence of the people under its control and has shortcomings in documenting information as a whole. According to the interview results, this is due to the lack of a designated person responsible for keeping related documentation. For the Operation variable, the company has not determined the type and level of control applied to external providers, and has not communicated the EMS to external parties. The company has also not reviewed or re-examined the emergency response procedures outlined in the EMS, and there has been no revision or periodic review of emergency preparedness. According to the interview results, this has never been done because external parties have never requested complete information about it. As for the emergency preparedness review, it has not been revised because the current method is considered sufficient to address the problems that occur. For the Performance Evaluation variable, the company has never calibrated or upgraded the equipment used for environmental monitoring. The company also does not communicate environmental performance information to related parties. The company has not integrated the EMS with other business processes and organizational strategies. Based on the interview, calibration of monitoring equipment has never been carried out because a third party handles it once a year. Integration of the EMS with other business processes has not been considered because the focus is on urgent needs.

Table 3. Dust Measurement Results

Point	Lowest Concentration (mg/m ³)	Highest Concentration (mg/m ³)	Average (mg/m ³)
1	0.064	5.267	0.684
2	0.016	11.500	0.997
3	0.253	0.815	0471

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Based on table 3. at the first point, the average concentration found was 0.684 mg/m³, with the lowest concentration of 0.064 mg/m³ and the highest concentration reaching 5.267 mg/m³. The measurement point located near the factory entrance which is often passed by cement trucks resulted in a significant spike in dust. This indicates a potential for significant health risks for workers in the area, especially related to lung disease. This has the potential to affect the quality of air inhaled by workers, especially those in positions near the entrance, such as security posts and administration offices.

The results of dust measurements at the second point showed an average dust concentration of 0.997 mg/m³, with a minimum concentration of 0.016 mg/m³ and a maximum concentration of 11,500 mg/m³. This maximum concentration exceeds the set threshold of 10 mg/m³ for dust, thus potentially increasing the health risk for workers in the area. Dust exposed in high concentrations, as measured at the second point, may contain fine particles known as "inhalable particles," which can penetrate deep into the respiratory system (alveoli) and settle in the lungs. If exposure lasts for a long time, it can increase the risk of developing lung diseases, such as silicosis, a lung disease caused by exposure to silica dust, which occurs in construction and concrete production workers. In addition, excessive dust exposure can worsen the condition of workers who already have underlying respiratory diseases.

The measurement results at the third point showed an average dust concentration of 0.471 mg/m³, with a minimum concentration of 0.253 mg/m³ and a maximum concentration of 0.815 mg/m³. Although the dust concentration at this point is lower than the first and second points, dust exposure can still be detrimental to workers' health, especially since the quality control location is quite close (about 300 meters) to the concrete production process area which is the main source of dust. Dust that drifts from the concrete production area to the quality control area can pollute the air, especially if there is no effective dust control system, such as ventilation or air filtration. Although the dust concentrations measured at the third point are still below the hazardous threshold, long-term exposure to dust can still have a negative impact on workers' respiratory health. At this location, many workers are in the vicinity of the area which is also close to the cafeteria and rest areas, so

workers are exposed to dust for a longer period of time, increasing the potential for health impacts.

DISCUSSION

Environmental Management System (EMS) is a system designed to manage and reduce the negative environmental impacts of a company's operational activities. The implementation of EMS in a concrete production company can help reduce the risks of occupational diseases (OD) through the control of environmental aspects that may lead to OD. The company has received ISO 14001:2007 certification. This indicates that the company has established clear regulations to ensure worker safety and environmental health. In this era of rapidly changing conditions, the company is prepared to face new challenges by applying the principles of Good Corporate Governance (GCG) and following ISO 14001 standards to ensure these standards remain up to date and in line with market needs.

Regarding the Context of the Organization clause, the company has performed very well. The organization has successfully understood its operational context, which includes both internal and external issues, including environmental conditions relevant to the organization's goals. However, one area requiring improvement is the understanding of stakeholders' needs and expectations. The organization does not fully monitor and review stakeholder information and their relevant requirements. This is an important aspect that needs to be improved to ensure a more comprehensive implementation of ISO 14001:2015.

In the implementation of the Leadership element in the ISO 14001:2015 standard, the company has shown several positive aspects in its leadership, particularly in terms of communication with employees. However, there are significant shortcomings in implementing the environmental policy. The company has not fully provided a clear framework for setting environmental objectives and, more importantly, has not shown full commitment to continuous improvement of the Environmental Management System (EMS) to enhance environmental performance.

In the implementation of the Planning element of the ISO 14001:2015 standard, the company has demonstrated commitment to managing natural resources sustainably and developing an

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environmental management system that covers waste management, energy use, and water management. However, several important aspects still require improvement in its implementation. Regarding actions to address risks and opportunities, it was found that the company has not fully considered the life cycle perspective in assessing environmental aspects. Additionally, in action planning, the company has not optimally considered technological options, as well as financial, operational, and business requirements. This condition could impact the effectiveness of environmental impact control, including dust control generated from the production process. The lack of optimal consideration of technology and operations directly impacts worker health, particularly related to dust exposure. Measurement results show poor dust levels in the workplace, which correlate with increased respiratory complaints and coughing among employees (Liang, McCoy, Tomasallo, & Meiman, 2023). This indicates that the lack of technological considerations in dust control contributes to the ongoing occupational health problems. Regarding environmental goals and planning to achieve them, it was found that the organization has not fully considered how to integrate actions to achieve environmental goals into its business processes. This indicates a gap between the set environmental goals and their practical implementation in daily operations. This condition could complicate efforts to control environmental impacts, including air pollution control, which could affect worker health.

The implementation of the Support element in the ISO 14001:2015 standard shows the company's commitment to environmental management, but several important aspects still require significant improvement for optimal implementation. In terms of resources, it was found that the organization does not maintain documented information as evidence of employee competence. This indicates a gap in the recording and documentation system, which can affect the effectiveness of employee competence development in managing environmental aspects. The absence of systematic documentation may also complicate the process of evaluating and developing targeted training programs to enhance employee skills in addressing environmental issues. A more serious problem was identified in the internal communication aspect, where the organization does not communicate relevant information about the

environmental management system across various levels and functions of the organization, including changes to the system. Furthermore, the company does not ensure that its communication processes allow employees to contribute to continuous improvement. This condition can lead to a gap in understanding and coordination between departments in managing environmental issues, including dust management, which can affect workers' health.

The implementation of the Operation element in the ISO 14001:2015 standard resulted in a relatively low overall score. While the company has shown some efforts in environmental management, many critical aspects still require significant improvement. In terms of operational planning and control, several fundamental weaknesses were found. The organization has not determined the type and level of control applied to external suppliers within the Environmental Management System (EMS). Additionally, regarding the product life cycle, the company has not established adequate controls to ensure environmental requirements are met in the design and development process of products and services. This condition could affect the overall quality of environmental impact control, including dust control, which can affect worker health. Moreover, the company has not optimally communicated relevant environmental requirements to external suppliers, including contractors. A very serious weakness was also identified in the aspect of preparedness and emergency response. The organization has not conducted regular testing of planned emergency responses. Even more concerning, the company has not routinely reviewed and revised the emergency processes and actions, especially after an emergency situation or test. This condition could increase the risk of unpreparedness in dealing with environmental impact-related emergencies, including the potential for excessive dust exposure, which could worsen the health of workers who already suffer from respiratory issues.

The company has implemented the Performance Evaluation element in a systematic way. It has identified relevant environmental performance indicators, such as raw material use, greenhouse gas emissions, and waste management. However, in the aspect of monitoring, measurement, analysis, and evaluation, it was found that the organization has not

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fully optimized ensuring that the monitoring and measurement equipment is properly calibrated or verified and maintained. In the management review aspect, the organization has not fully considered opportunities to enhance the integration of the EMS with other business processes and any implications for the organization's strategic direction. Nevertheless, this implementation has had a positive impact on raising awareness and commitment among employees in managing the environment sustainably.

Implementation of Improvement elements comprehensively, the company's performance has increased significantly. This achievement shows that the company has successfully implemented all aspects of improvement according to the ISO 14001:2015 standard effectively and comprehensively. This success is reflected in the company's ability to identify improvement opportunities, manage non-conformities, and take appropriate corrective actions. By considering all aspects, including background, vision and mission, quality management, and internal environmental management. The company has demonstrated strong capabilities in implementing the ISO 14001:2015 standard. In addition, it has committed to improving the efficiency and effectiveness of concrete and aggregate production while ensuring that the production process is environmentally friendly. However, the low implementation score on the Operation element is directly correlated with health problems experienced by workers, especially those related to respiratory problems due to dust exposure. The operational control system, communication with external parties, and emergency response preparedness that have not been developed have the potential to worsen the environmental impact on employee health. This shows a gap between the environmental goals set and their practical implementation in daily operations. This condition can complicate efforts to control environmental impacts, including air pollution, which can affect worker health.

According to previous studies, various types of dust (such as cement dust, coal dust, silica dust, and organic dust) have a significant impact on decreasing lung function, depending on the characteristics of the particles. Particles such as silica dust are often associated with a higher risk of serious lung diseases, including lung cancer (Abidin, Henita, Rahmawati, & Maziya, 2021). Other studies also state that even

though dust levels are still below the threshold, chronic exposure can cause lung function disorders such as mild to moderate restrictive disease (Azhar, Majdpour, Mesa, Rubens, Chaparro, Saxena, & Jimenez, 2025). Risk factors such as age and duration of exposure have a significant relationship with decreased lung capacity, while smoking habits do not show a direct relationship in some cases. Excessive dust exposure can have a negative impact on lung health, especially if it is continuous. Inhaled dust can irritate the airways, trigger inflammatory reactions, and over time cause mild respiratory disorders or chronic lung disease. This condition can cause problems such as chronic cough, shortness of breath, and increased risk of respiratory tract infections (Hikmiah, 2018).

CONCLUSION

Although the company has implemented the ISO 14001:2015 standard well, some areas still require improvement, particularly in the "Operation" element. Operational controls, communication with external suppliers, and emergency preparedness must be enhanced to minimize environmental impacts and health risks to workers. While the "Performance Evaluation" element is quite good, there are shortcomings in the calibration of monitoring equipment, which could affect the accuracy of data related to environmental impacts. On the other hand, the "Improvement" element shows optimal results with a 100% achievement, reflecting the company's commitment to continuous improvement. Therefore, although the company has taken positive steps in the implementation of the environmental management system, dust control and increased protection for workers remain important focuses to prevent work-related diseases that are still occurring.

SUGGESTION

To improve the effectiveness of the Environmental Management System (EMS), the organization needs to strengthen operational controls and communication with external suppliers to ensure that all processes and business partners meet the established environmental standards. Additionally, emergency preparedness must be enhanced through regular evaluations of emergency response procedures, so that responses to critical situations can be faster and more effective. It is also crucial to ensure the routine

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maintenance and calibration of monitoring equipment, so that the data produced remains accurate and reliable for decision-making. Furthermore, the EMS should be more deeply integrated into core business processes, such as strategic planning, procurement, and production, so that environmental aspects become an inseparable part of every business decision and promote a culture of sustainability throughout the organization.

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