

Challenges and Opportunities for Indonesian Environmental Management in The Industry 4.0 Era

Ayu Shinta Dewi

Faculty of Economics and Business, Airlangga University

ayu.inta.dewi-2023@feb.unair.ac.id

ABSTRACT

The issuance of Law Number 11 of 2020 regarding Job Creation was welcomed by most business actors, but on the other hand it left concerns about the risk of massive environmental degradation. One of the efforts to synchronize the spirit of accelerating business licensing with environmental protection and management is the industrial framework 4.0. The form of Industry 4.0 which is integrated, agile, accurate, synchronized with each other, and encourages acceptance of new perspectives with virtual-digital aspects, enables innovation in the use of new methods in environmental management. So far, the government of the Republic of Indonesia has prepared sufficient regulatory and institutional arrangements to accommodate the conceptual industry 4.0 into the challenges of sustainable environmental management. In carrying out the transformation of sustainable development from conventional concepts towards 4.0, human resources are needed who are able to see opportunities and build the required competencies.

Keywords: *environmental management, sustainable development, industry 4.0, EIA, Amdal, environmental modeling, online monitoring, environmental management system.*

ABSTRAK

Terbitnya UU Nomor 11 Tahun 2020 tentang Cipta Kerja disambut baik oleh sebagian besar pelaku usaha, namun di sisi lain meninggalkan kekhawatiran akan risiko degradasi lingkungan secara masif. Salah satu upaya untuk menyinkronkan semangat percepatan perizinan usaha dengan perlindungan dan pengelolaan lingkungan adalah kerangka industri 4.0. Bentuk Industri 4.0 yang terintegrasi, gesit, akurat, disinkronkan satu sama lain, dan mendorong penerimaan perspektif baru dengan aspek virtual-digital, memungkinkan inovasi dalam penggunaan metode baru dalam pengelolaan lingkungan. Sejauh ini, pemerintah Republik Indonesia telah menyiapkan pengaturan regulasi dan kelembagaan yang memadai untuk mengakomodasi industri konseptual 4.0 ke dalam tantangan pengelolaan lingkungan yang berkelanjutan. Dalam melakukan transformasi pembangunan berkelanjutan dari konsep konvensional menuju 4.0, dibutuhkan sumber daya manusia yang mampu melihat peluang dan membangun kompetensi yang dibutuhkan.

Kata kunci: manajemen lingkungan, pembangunan berkelanjutan, industri 4.0, AMDAL, Amdal, pemodelan lingkungan, pemantauan *online*, sistem manajemen lingkungan.

INTRODUCTION

After the issuance of Republic Indonesia's Law Number 11 of 2020 regarding Job Creation, there are 11 (eleven) issues of ease of doing business in Indonesia. If we look further, the theme of ease of doing business in the Job Creation Law is discussed

in chapters III and chapter VI. Two issues related to the ease of doing business in chapter III "*Improving the Investment Ecosystem and Business Licensing*" are the application of risk-based business licensing and the simplification of basic permits, including spatial, environmental and building permits.

The OSS (Online Single Submission) is a government-provided electronically integrated business licensing service system that aims to simplify the process of obtaining business licenses. While the Job Creation Law maintains the basic concept of environmental permits as a requirement for obtaining business licenses that include environmental provisions, it does not alter this concept fundamentally. The integration process of environmental permits with business permits is carried out in three stages, which include the preparation of environmental documents, obtaining environmental approvals, and obtaining business permits.[1]

Ease of business licensing, giving fresh air to industrial growth. Industrialization has had a positive impact in the form of increasing national income, economic stability, increasing job opportunities, stimulating progress in other sectors, and increasing the balance of payments. The other side of industrialization also brings negative impacts such as urbanization, environmental pollution, and income inequality.

Based on an analysis of the environmental cost structure, it has been found that the majority of environmental costs in Indonesia are related to the depletion of natural resources, including minerals and energy resources, which account for around 55.22% of the total environmental costs. The second highest contributor to environmental costs, making up 38.07%, is the cost of environmental damage caused by air pollution. The destruction of ecosystems comes in third, contributing 6.71% of the total environmental costs. Air pollution alone represents a significant portion of Indonesia's environmental costs, ranking as the second largest contributor after the depletion of non-renewable resources. The cost of environmental damage caused by air pollution, excluding water and waste pollution, is estimated to be Rp. 348.35 trillion, which makes up 38.07% of the total environmental cost value and is equivalent to around 6.23% of the total NDP. [2]

To ensure a successful development process, Indonesia must establish a precise and all-encompassing system for managing and regulating the environment. Indonesia is among the 17 nations globally recognized for its exceptional biodiversity. [3]Indonesia boasts the world's largest expanse of tropical forests and possesses exceptionally diverse coastal and marine ecosystems. Its abundant natural resources have propelled the country to become a significant exporter of minerals, energy sources, timber, and agricultural products. However, despite its successes, Indonesia is still grappling with the challenge of mitigating the environmental effects of economic activities. In 2015, Indonesia ranked as the fourth-largest emitter of greenhouse gases worldwide. [4], Indonesia faces environmental challenges caused by deforestation and peat forest fires, as well as the burning of fossil fuels for energy,

leading to emissions. The country also confronts unsustainable practices in natural resource extraction, high pollution levels, and environmental degradation. The Fourth Industrial Revolution, also known as Industrial Revolution 4.0, is a novel industrial paradigm featuring sophisticated manufacturing capabilities. What sets it apart from its three predecessors is the seamless integration of its components, including people and their work, machines and tools, and technology. Industry 4.0 is characterized by enhanced integration, agility, precision, synchronization, and openness to novel ideas, culture, and technology. Key attributes of Industry 4.0 are its virtual and digital dimensions.[5].

Although the technology employed in Industry 4.0 is not entirely novel, its integration with conventional methods has led to a more dynamic and responsive industry. This technology has enabled production processes to become more efficient, streamlined, and faster, ultimately enhancing overall production performance [6].

Sustainability refers to efforts to minimize negative impacts on environmental, social and economic relations, while simultaneously addressing issues of climate change, pollution and the use of unlimited resources. Industry 4.0 is a combination of intelligent machines, production, processes and systems that form a sophisticated interconnection network. It also emphasizes the notions of coherence, digitization and interrelatedness of all productive units in an economy, creating a virtualization of the real world within a large information system.

Industry 4.0 is expected to have a beneficial impact on the three pillars of sustainability, namely economic, environmental, and social, which are commonly known as the Triple Bottom Line. This concept has evolved into the 5 P's (People, Prosperity, Planet, Partnership & Peace) of the Sustainable Development Goals (SDGs). The Triple Bottom Line represents a company's core values that promote sustainable practices, and it encompasses the following principles: economic development, including the promotion of profits, job creation, consumer attraction, cost reduction, risk anticipation and management, and competitiveness over time; environmental responsibility, including energy and resource conservation, the use of renewable energy, pollution reduction, recycling, packaging minimization, and carbon emissions reduction; and social welfare, including the creation of working standards and conditions, society improvement, and the development of social responsibility in products and services. [7]

Indonesia's progress and development must align with the global growth of Industry 4.0. Maintaining economic competitiveness requires ensuring that excessive environmental degradation does not occur. This means that development in a particular area must not exceed the carrying capacity and local environment's capacity. All economic activities, including the manufacturing industry, natural resource extraction, infrastructure development, logistics, and digital economic activities, must be integrated with a sustainable framework for environmental protection and management.

The existence of Law No. 11 of 2020 regarding Job Creation, must be able to be a driving force for the growth of a business ecosystem which is a pillar of the national economy, but on the other hand the pressure of business growth on environmental quality is a common challenge that must be minimized. One of the opportunities that arise from the potential for environmental degradation, is the presence of experts who are able to adopt the latest technology in environmental management in the industrial era 4.0.

LIBRARY STUDIES

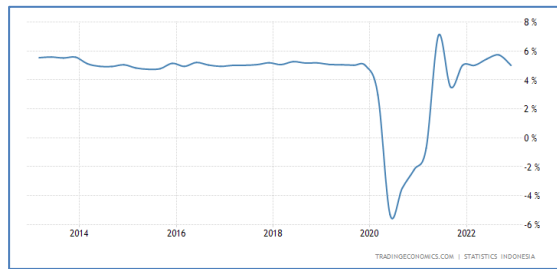
1. Environment and Industrial Management 4.0

The concept of Industry 4.0 was first introduced in Germany at the "Hannover Fair" in 2011, and was proposed as a new high-tech strategy for German economic policy. This marked the beginning of what is now known as the Fourth Industrial Revolution. As a result, scholarly publications discussing Industry 4.0 began to emerge in 2011 and saw a significant increase in numbers around 2013. Since then, many scholars, researchers, and business professionals have shown interest in the new industrial model and its technological capabilities.

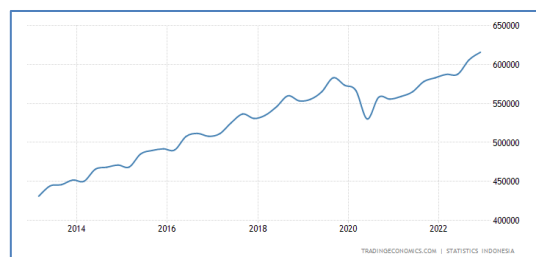
Industry 4.0 is an innovative industrial model that encompasses a wide range of technologies aimed at optimizing industrial performance by increasing integration, virtualization, and digitalization. This model is designed to enable rapid response to internal and external demands while maintaining sustainable environmental management. The six key principles that underpin Industry 4.0 include decentralization, virtualization, interoperability, modularity, real-time capability, and service orientation, all of which are strongly related to advanced technology.

Indonesia's Gross Domestic Product (GDP) annual growth rate has been relatively stable in the last ten years, averaging 5.3%. However, in the period of 2021-2022, it recorded the highest growth rate of 7.12%. It is important to note that the GDP decrease in the period of 2020-2021 is not considered in this analysis due to the Covid-19 pandemic that has affected the entire world. In particular, the GDP from the manufacturing sector has been continuously increasing over the past ten years, reaching its highest point of Billion IDR 615758.30 in December 2022.

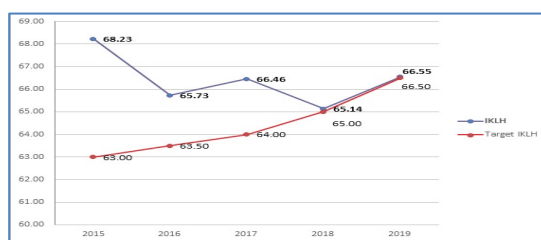
In contrast, Indonesia's Environmental Quality Index (IKLH) had its lowest score in five years in 2020, with a rating of 65.14. This index assesses the condition of national environmental management and provides a summary of the environmental quality index for each province and region. It is based on three key indicators: water quality index (TSS, DO, BOD, COD, total phosphate, fecal coliform, and total coliform), air quality index (SO₂ and NO₂), and land cover quality index (land cover area parameter). Higher scores on the index indicate better environmental quality. [8]



(a)



(b)



(c)

Figure 1. (a) Indonesia's Gross Domestic Product Annual Growth Rate (%); (b) Indonesia Gross Domestic Product From Manufacturing (Billion IDR); (c) Indonesia's Environment Quality Index

The correlation between economic growth and a decrease in the environmental quality index shows that the concept of development in Indonesia needs systemic improvement. Environmental management in conventional models (mainstream economic model and green growth) is very effective in terms of guidance, supervision and enforcement. Traditional industrial models are not conducive to sustainable industrial performance as they consume excessive natural resources, generate high levels of waste, and have inefficient logistics processes. To avoid low or controlled environmental problems, Indonesia needs to move away from the Environmental Economic trap. All stakeholders must recognize that the universe has limits and must implement Ecological Economics in all aspects to promote environmental sustainability.



Figure 2. Development of the Global Economic Model

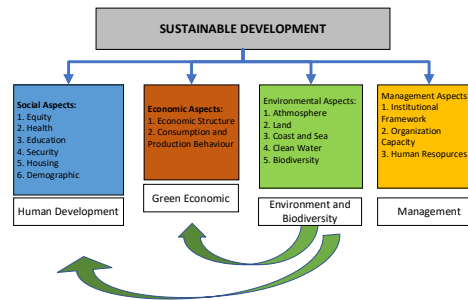


Figure 3. The Concept of Sustainable Development

The social, economic and governance (institutional) pillars on the concept of sustainable development have received a lot of attention from the government. Meanwhile, environmental aspects are still being neglected and not holistically integrated into social/economic aspects. One way that is believed to be able to achieve the ideals of sustainable development is to integrate all stages of development into environmental aspects, starting from the planning, construction to operational stages. This aims to increase efficiency, increase market opportunities, and comply with regulations. Adoption of industry 4.0, technology, methods and the latest scientific developments is absolutely necessary as a reference in the concept of planning, implementation and regular evaluation [7].

2. Environmental Management Opportunities at The Planning Stage

The development of science in the last decade has provided methods and tools that can be adopted in planning for sustainable development in Indonesia, especially for issues that focus on environmental aspects. This method, which is relatively new, is an opportunity to be developed and widely applied to all types of businesses and/or activities.

Environmental Impact Analysis (AMDAL)

The definition of AMDAL according to Law Number 11 of 2020 is definition refers to AMDAL, which is a comprehensive analysis of the potential environmental impacts of a proposed business or activity that is required before any decision can be made about whether to proceed with the project. The study must be included in the business permit or central or local government approval, and it serves as a crucial basis for decision-making regarding the implementation of the proposed business or activity. The purpose of AMDAL is to identify potential environmental risks and to

develop strategies to minimize or mitigate any negative impacts that may result from the proposed project. Law Number 11 of 2020 places special emphasis on AMDAL procedures that are integrated with other business permits, in terms of seeking to manage the quality of wastewater, air emissions, traffic management, and management of hazardous and toxic waste (B3) from the planning stage.

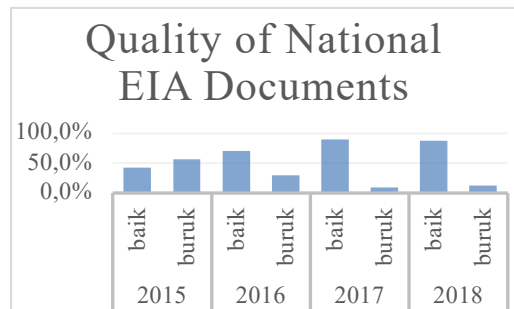


Figure 4. Quality of EIA Documents

Source: [9]

Most of the EIA documents produced nationally show that quality is getting better from year to year. However, the assessment of document quality is still focused on consistency tests, depth tests and relevance tests. The focus of the AMDAL/EIA is on studying the major significant impacts needed in decision making, so that the use of the latest methods and technology is absolutely necessary in estimating the magnitude of the impact in the AMDAL, such as environmental modelling.

A comparison between the Job Creation Law and a relevant preceding environmental law.

Governmental Regulation Number 27/2012 on Environmental Permit	Job Creation Law Law Number 11/2021
The Regent/Mayor/Governor proposes the projects to the Minister of Environment and Forestry accompanied with documents for detailed spatial planning and strategic environmental assessment report.	Projects that will take place in areas covered by a detailed spatial plan are exempted from the obligation to conduct environmental impact assessment
Following pre-approval by the Minister, project applicants should submit a plan on environmental management and monitoring efforts (environmental feasibility analysis for small scale project)	The project proponent is eligible to apply for an in lieu of an operational permit
Once the above document has been considered feasible, the project proponent is eligible to apply for operational permit	

Figure 5. Comparison

Source: [10]

The main objective of the Job Creation Law in Indonesia is to simplify the environmental assessment requirements to facilitate business activities. Under the new regulations, if a project is carried out in an area with a detailed spatial plan, it is no longer mandatory to conduct an Environmental Impact Assessment (EIA). Previously, this exemption was only granted through a strict procedure, where the Regent/Mayor/Governor had to submit a project proposal, along with detailed spatial planning and Strategic Environmental Assessment (SEA) documents, to the Minister of Environment and Forestry for approval. Once approved, only small-scale projects were required to undergo an environmental feasibility study report (UKL/UPL). However, this procedure was not consistent with Article 22 of Act No. 32 of 2009,

which mandates that any project with a potential for significant environmental impact must be accompanied by an EIA report.

Under the Job Creation Law, however, any project conducted in an area with a detailed spatial plan is exempt from the obligation to conduct an EIA report, without the need for a strict procedure or approval from the Minister of Environment and Forestry. This exemption is intended to simplify the environmental assessment process and make it easier for businesses to operate in Indonesia. Critics of the Job Creation Law have argued that this exemption could lead to environmental degradation and damage, as there is no requirement for an EIA report to assess the potential impact of a project on the environment.

To empowering AMDAL/EIA in Indonesia, Environmental modelling is a depiction of environmental processes and the relationships between their constituent components/variables using logical and mathematical representations.

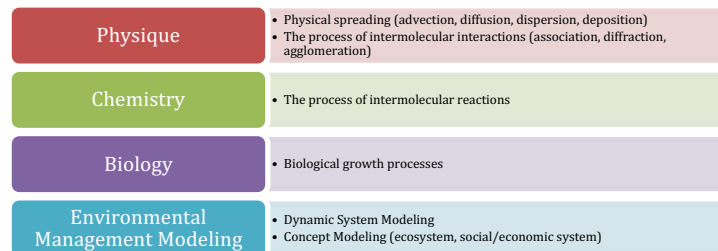


Figure 6. Scope of Environmental Modeling

Some examples of models and software used for Modelling environmental impacts on surface water include:

1. QUAL2Kw (<http://www.qual2k.com/>)
2. SWMM (Storm Water Management Model),
3. WASP (Water Quality Analysis Simulation Program)
4. AQUATOX (<https://www.epa.gov/ceam/aquatox>)
5. BASINS (Better Assessment Science Integrating Point and Non-point Sources),
6. SMS (Surface Water Modeling System)
7. MIKE powered by DHI

While examples of models and software used for modelling environmental impacts on air and noise, include:

1. HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory)
2. AERMOD
3. CALPUFF
4. iNoise

Scientifically, the use of the model in the approach to estimating the magnitude of the environmental impact of a business and/or activity is quite justifiable, as long as it follows the required method. The stages of the environmental modelling process include at least:

- a. Conceptualization and Identification
- b. Mathematical representation
- c. Numerical implementation
- d. Parameter estimation and calibration
- e. Hypothesis test
- f. Validation

The application of environmental modelling to EIA studies is very helpful in determining the area of impact management, calculating environmental costs, and evaluating environmental management at the construction and operational stages.

Life Cycle Assessment (LCA)

Life Cycle Assessment (LCA) is a technique utilized to assess the environmental consequences of a product throughout its entire life cycle, starting from the procurement of raw materials, production, utilization, and disposal. The fundamental concept of LCA is that an industrial system cannot be evaluated separately from the environment in which it exists. The LCA approach takes into consideration all phases of a product's life cycle, including the extraction of raw materials, manufacturing processes, transportation, use, and end-of-life disposal or recycling.

METHOD

The methodology of Life Cycle Assessment (LCA) involves four main components, which include defining the objectives and scope, conducting a Life Cycle Inventory (LCI), conducting an impact assessment, and assessing opportunities for improvement. LCA is often referred to as "cradle to grave" as it evaluates the environmental impact of a product throughout its entire life cycle. LCA can be used to aid a company's business strategy in decision-making, improving product and process quality, and examining the environmental aspects of products. The procedure for conducting LCA is part of the ISO 14000 series, specifically ISO 14040:2006 (which replaced the previous version, ISO 14044, and has now been updated with versions from ISO 14041 to ISO 14043).

Based on the Regulation of the Minister of Environment and Forestry Number 1 of 2021 concerning the Company Performance Rating Program in Environmental Management (PROPER), life cycle assessment (LCA) is one of the main parameters for evaluating beyond compliance. LCA can play a role in various strategic efforts to reduce environmental impact, as well as increase product value, such as:

1. Determine the basic value of the p'oduct's environmental performance (baseline)
2. Determine the part of the product-system that has a “big” impact on the total impact (hotspots)
3. Determine areas of improvement
4. Perform performance improvement/impact reduction (innovation)

The increase in environmental performance which is shown quantitatively from the life cycle assessment, has a close correlation with the increase in product competitiveness, which of course will have a direct impact on the added value and efficiency of the product. LCA provides tools for manufacturers to design process flows, select raw materials, select auxiliary materials, energy and other resources that have the least impact on the environment. On the other hand, consumers can make an assessment of the types of products and services to be used, according to the smallest environmental impact they cause.

3. Environmental Management Opportunities at The Operational Stage

Online Environmental Monitoring System

Environmental monitoring is an activity to monitor and supervise the existing or real conditions of a point/location/area at a certain time and according to predetermined parameters. The purpose of environmental monitoring varies, including complying with regulations or provisions from the government, evaluating company environmental management, to monitoring and evaluating the c'mpany's operational and production efficiency. Every business and/or activity that is equipped with a permit has the obligation to carry out periodic environmental monitoring.

One of the advanced environmental monitoring methods that can be applied is online environmental monitoring. The development of information technology has been adopted by the Ministry of Environment and Forestry to monitor environmental quality in real time, through several information systems that have been built and integrated. Several systems that have been developed and operational include:

1. ONLIMO (Real Time River Water Quality Monitoring System)
2. PARING (Continuous and Networked Wastewater Quality Monitoring System)
3. SISPEK (Automatic, Continuous and Integrated Industrial Emission Monitoring System)
4. AQMS (Air Quality Monitoring System)
5. TMAT (Groundwater Level Monitoring System)\SILAT (Open Access Land Information System)
6. SIKAL (Sea Water Quality Information System)
7. SIMPEL (Environmental Electronic Reporting Information System)

Real-time monitoring systems such as SPARING and SISPEK, provided by the Ministry of Environment and Forestry, require the involvement of business entities

and activities. The implementation of the Minister of Environment and Forestry Regulation No. P.93/MENLHK/KUM.1/8/2018 regarding the continuous and network monitoring of wastewater quality for businesses and activities has made continuous and online environmental monitoring a new obligation and challenge for companies in their environmental management practices.

Environmental monitoring can be carried out periodically (periodic) and continuously (continuous). Monitoring that is carried out continuously can provide data within a certain time span so that it can provide analysis in the form of trends. However, this continuous monitoring faces challenges such as a lack of operator personnel and monitoring point locations that are remote and difficult to reach. To answer these challenges, the technology of online remote environmental monitoring system (Remote Online Environmental Monitoring System) was born.

An online remote environmental monitoring system utilizes cellular technology, the internet, and cloud data servers as a means to connect sensors such as Multiparameter Probes which can measure water/air quality parameters with a monitoring computer or mobile device. With this system, monitoring and data collection can be carried out continuously unattended (unattended logging). Then, by utilizing cellular or satellite networks, monitoring devices can be placed or installed in locations that are far from offices and monitoring areas. Parameter data will continue to be collected and recorded and then sent to a data center or cloud data server which can be accessed via a computer (PC) and mobile device (smartphone/tablet) in real time anywhere and anytime.

Judging from the illustration above, the Remote Online Monitoring System consists of several instruments, namely:

a. Monitoring sensors

Monitoring sensor or probe is a tool used to measure and retrieve monitoring parameter data. Sensors are usually placed and installed in direct contact with objects or materials to be monitored such as river water, waste water, air in certain areas, and so on.

b. Data Loggers

A data logger is a tool that functions as a data recorder and sends it to a data center (cloud server). Data loggers are usually equipped with connectivity capabilities to GSM networks or directly connected to satellites depending on the specifications of the data logger.

c. Power supply

The power supply is the operational resource for sensors and data loggers. These resources can be in the form of batteries and solar panels (solar panels).

d. Data center (cloud data server)

The data center (cloud data server) is a data storage facility obtained from sensors. Stored data can be accessed directly to see the condition of monitoring points in real time. Data can be further analyzed to see trends.

e. Viewing device (viewing device)

Data stored in the data center can be accessed via a PC or mobile device connected to the internet network. The data display is the real time condition of the monitoring point.

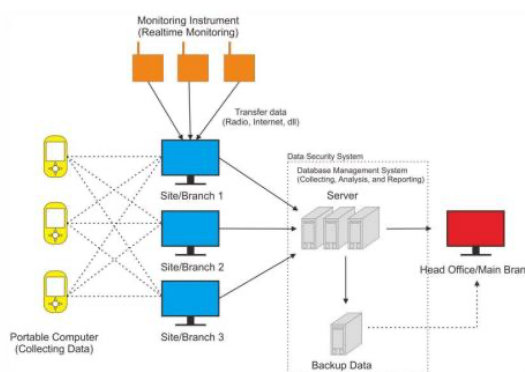


Figure 7. Illustration of Online Monitoring System

The online environmental monitoring system provides various benefits and advantages, including:

1. Ease of accessing data anywhere and anytime
2. Data from multiple locations can be monitored simultaneously
3. Data is obtained continuously and can be customized by specifying the time range in which data is retrieved
4. Installation or installation is easy
5. Can send notifications or alarms to provide early warning so that preventive actions can be taken to reduce the potential for greater loss or damage.
6. Cost efficiency by reducing dependence on human labor
7. Incoming data can be used for process optimization in the framework of controlling water pollution and air pollution control.

Environmental Management System (EMS)

In line with ISO 14001:2015, an environmental management system refers to a system that comprises an organization's structure, responsibilities, planning of activities, and policies or regulations relating to the environment, with a particular emphasis on the surrounding environment.

This system is part of other systems that have received international recognition. International world recognition can be proven through a certificate given by a certification body which is directly under the international standardization organization, in this case ISO.

This international standard for EMS was published by the Indonesian government in September 1996 in the form of ISO 14001 and ISO 14004. The Indonesian government then adopted it to become the Indonesian National Standard (SNI) and became SNI-19-14001-1997 and SNI-19-14001-1997. The environmental management system is an international best practice and is suitable to be used as a core criterion in implementing business in Indonesia in a sustainable manner. Therefore, there is a great need for uniform collaboration between central and regional companies so that the application of the ISO 14001 environmental management system can be more numerous and evenly distributed. SNI ISO 14001: 2015 is the latest standard that has integrated the environment into business processes which also considers issues of opportunities and risks of products, services and company activities. With the alignment of these standards into business processes, SNI ISO 14001:2015 can be a benchmark for a company to carry out environmental management that can still contribute to the environment and sustainable development.

The Indonesian version of the EMS standard has also taken into account considerations from a life cycle perspective carried out from its activities, products and services. This starts from raw material processing, delivery, distribution, production process, use, to final processing.

Application of environmental management systems for resource utilization in the following areas:

- a) Energy efficiency;
- b) Emission reduction;
- c) Water efficiency and waste water load reduction;
- d) Reduction and utilization of hazardous waste;
- e) Reduction and utilization of non-B3 waste; And
- f) Biodiversity protection

The environmental management system has been adopted into PROPER as a criterion beyond compliance. All fields included in the environmental management system require separate studies and detailed analysis. [11]

Environmental Audit for High Risk Activity

Environmental Audit is also carried out for companies whose production activities are at risk of causing harm to the company's environment and the surrounding environment. Environmental risk analysis for companies can be carried out using flowcharts or environmental audits. The definition of an environmental audit states that an evaluation is carried out to assess the compliance of those in charge of a business and/or activity with legal requirements and policies set by the government.

The government in implementing environmental audits has the following functions:

- 1) is a document of a business or activity concerning the implementation of management, monitoring, reporting or plans to change regulations and internal company processes
- 2) a tool for identifying internal environmental problems, and
- 3) a tool for evaluating the performance of environmental organizations and divisions.

Meanwhile, the benefits of an environmental audit are:

- 1) to identify environmental problems,
- 2) avoid sanctions due to errors in management procedures,
- 3) avoid material loss,
- 4) identify potential cost savings, and/or
- 5) as a company document.

The difference between an environmental audit and an AMDAL is quite fundamental, especially the position that an AMDAL is carried out prior to an activity, while an audit is carried out after the activity operates.

RESULT AND DISCUSSION

Table 1. Differences between Environmental Audit and EIA

No.	Environmental Audit	EIA
1.	Carried out after the activity and or business takes place	carried out before the activity and or business takes place (planning stage)
2.	continuously for a certain period of time	only once before the activity takes place
3.	the scope of the problem is only on the case or thing at hand	The scope of the problem covers various aspects and is long term
4.	Voluntary	Mandatory
5.	Confidential	Open and involve the community

Source: [12]

In efforts to protect and manage the environment, business actors and/or activities that are required to carry out various instruments such as environmental technical approvals, EIA/UKL-UPL, environmental approvals and Environmental Risk

Analysis (environmental audits), are given incentives and disincentives. Providing incentives and disincentives based on performance achievements and their adherence or compliance with laws and regulations and provisions in environmental law.

One of the incentives and disincentives implemented in environmental management is by awarding companies or business actors whose activities control environmental pollution and/or damage and manage hazardous waste. This award is given through the Corporate Rating Assessment Program in Environmental Management or abbreviated as PROPER.

CONCLUSION

With the current conditions, Indonesia has sufficiently provided a legislative system that guarantees the implementation of sustainable development. However, in order to realize the ideals of sustainable development, relentless efforts from all parties are required. One important aspect in ensuring the implementation of sustainable development within the framework of industry 4.0 is the availability of competent and sufficient human resources to carry out environmental planning, as well as to evaluate/audit ongoing activities. The readiness of domestic resources to support the accelerated implementation of an integrated environmental information system (SPARING, ONLIMO, SISPEK, etc.) is also absolutely necessary, so that technology is available that is cheap, reliable, and has measurable validity.

The key to the concept of sustainable development in the industrial era 4.0 is commitment. The person in charge of the business must be committed to implementing all the tools and technology that allows for process efficiency, impact reduction, waste reduction, selection of environmentally friendly raw materials/auxiliary materials, and conducting regular monitoring or auditing according to their obligations. The government must continue to encourage business actors to comply with laws and regulations indiscriminately, in some cases law enforcement measures are taken if necessary. The scientific community (researchers, academics, consultants) provides the latest applicable products, technologies and methods, so that they can be implemented by business actors, and as a basis for evaluation by the government. Sustainable development can only be achieved by integration and collaboration between all parties.

BIBLIOGRAPHY

- Badan Standardisasi Nasional. (2015). *Standard Nasional Indonesia (SNI): Environmental management systems—Requirements with guidance for use (ISO 14001:2015, IDT)*. Jakarta: BSN. [11]
- Chrysolite, H., Umar, F., Dini, M., Wibowo, A., Jaeger, J.-C., & Ge, M. (2020). *Looking past the horizon: The case for Indonesia's long-term strategy for climate action*. World Resources Institute. [4]
- Data and Information Centre, Ministry of Environment and Forestry. (2020). *Environmental quality index 2019*. Ministry of Environment and Forestry. [8]
- Directorate of Prevention of Environmental Impacts on Business and Activities, Ministry of Environment and Forestry. (2019). *Government agencies performance report*. Ministry of Environment and Forestry. [9]
- Hadi, S. P., & Rachmawati, H. A. (2023). A sustainability review on the Indonesian Job Creation Law. *Heliyon*, 9. [10]
- Nuraeni, A. H. (2021). Simplified analysis of environmental permits integrated through OSS (Online Single Submission). *Jurnal Ilmiah Widyaaiswara (JIW)*, 1, 45-54. [1]
- Olah, J., Aburumman, N., Popp, J., Máté, D., Kitukutha, N., Haddad, H., & Namanya, J. (2020). Impact of Industry 4.0 on environmental sustainability. *Sustainability*, 12, 4674. [5]
- Organisation for Economic Co-operation and Development (OECD). (2019). *OECD green growth policy review of Indonesia 2019*. OECD Publishing. [3]
- Pereira Carvalho, A. C., Chaves, P. A. P., & Gonçalves, N. G. P. C. (2020). *Industry 4.0 technologies: What is your potential for environmental management?* IntechOpen. [6]
- Pirmana, V., & A. S. A., A. A., Y. R. H., & A. T. (2021). Environmental costs assessment for improved environmental-economic. *Journal of Cleaner Production*, 280. [2]
- Syarif, L. M., & Gultom, W. A. (2015). *Hukum lingkungan: Teori, legislasi dan studi kasus*. Kemitraan Partnership. [12]
- Tjahjadi, B., Mardijuwono, A. W., & Fernando, M. S. N. (2021). Good corporate governance and corporate sustainability performance in Indonesia: A triple bottom line approach. *Heliyon*, 7, e06453. [7]