

Readiness Assessment of Pasuruan Industrial Estate Rembang (PIER) Towards Sustainable Industrial Estate

Hotnida Nainggolan^{1,2*}, Ni Wayan Surya Wardhani², Amin Setyo Leksono², Imam Santoso²

¹Jayapura University of Science and Technology,

Sosial Padang Bulan St., Jayapura, Papua 99351, Indonesia

²Doctoral Program in Environmental Sciences, Brawijaya University,

Veteran St, Malang 65145, Indonesia

*Correspondence email : hotnida.ustj@gmail.com

ABSTRACT

Global awareness towards sustainability are putting pressure on industries worldwide to implement procedures to manage the elements of sustainability for an industrial development. This study aims to assess the readiness of Pasuruan Industrial Estate Rembang (PIER) towards sustainable industrial estate. This research was conducted using qualitative methods with the type of research in the form of case studies. Six parameters are assessed based on the concept formulated by Ernest Lowe (2001) that include natural system integration with environmental capacity-bearing capability, sustainable energy and water use, integration of output and waste material flows, efficient industrial estate management, environmentally friendly infrastructure design and integration between industrial estates and social communities, contributing to local economic development. Using a Likert scale of 1 to 3 to assess the level of application of EIP principles in the PIER industrial estate, the results obtained are that two EIP principles have not been applied at all and four principles have not been fully implemented.

Keywords: assessment, scales, sustainability

INTRODUCTION

One of the challenges confronting the world of the twenty-first century is the consumption of natural resources on the one hand, and the decline in environmental quality on the other, in relation to industrial production systems that are commonly used today. Robert Frosch and Nicholas Gallopoulos, in their article Strategies for Manufacturing, predict that if natural resource consumption remains constant and no new or substitute natural resources are discovered, the world's industry will cease to exist by 2030 (Peck, 2004). Concerns about the future have led to the emergence of the concept of industrial sustainability which reconsiders the relationship between industrial development and environmental management. The term "sustainability" implies that natural resources should be used at levels less than or equal to those that can be replaced by natural or other equivalent resources.

In Indonesia, industrial sector is an important role as a driver of national economic growth. Based on data from the

Ministry of Industry (2020), the industrial sector contributed 19.86% to the national gross domestic product (GDP), which is currently the largest contributor to the national economy. However, the conventional industrialization process, which has relied on high energy and raw material consumption, has been recognized globally as one of the potential causes of various ecological environmental problems (Sujiman, 2016).

In addition, the rapid growth in the number of industrial estates in Indonesia, with a growth of 47.5% in the last 5 years (Ministry of Industry, 2020), inevitably requires enormous natural resources, which if not managed properly, can cause significant environmental problems, especially industrial waste and resource depletion. According to Law Number 3 of 2014, an industrial estate is an area where industrial activities are concentrated, equipped with supporting facilities and infrastructure developed and managed by an industrial estate company. Meanwhile, the objectives are to control the use of space, to increase efforts to develop

environmentally sound industries, to accelerate industrial growth in the regions, to increase industrial competitiveness and to provide location certainty in infrastructure planning and development.

Several studies related to industrial estates in Indonesia have been done, including Sunarjo (2006) and Wikaningrum (2016) in the Jababeka Industrial Estate; Sulaiman (2008) in the Cilegon Industrial Estate; Kodrat (2011) in the Medan Industrial Estate; Budihardjo (2013) in the Semarang Industrial Estate; Budiyanto (2015) in the East Jakarta Industrial Estate; and Hadi (2019) in the Gresik Industrial Estate. The majority of the results did not reveal a sustainable industry, particularly in the field of environmental management.

The Sustainable Development Goals (SDGs) Agenda clearly states that the sector's key development activities should include efforts to protect the environment and reduce waste (United Nations, 2015). One of the foundations and key steps towards sustainability adopted by many industries in several countries is Eco Industrial Park (EIP) that formulated by Lowe (Tessitore *et al.*, 2015). Broadly, EIP can be defined as a business community that is located together in an area and collaborates in managing environmental problems and resources to improve environmental, economic, and social performance (Lowe, 2001). Lowe said that there is no blueprint for EIP, so when planning and implementing the EIP, the vision in the EIP concept must be translated into a more operational concept, adapted to economic, ecological, social characteristics, and local culture. EIP has developed and is widely used in addressing various aspects, including, resource efficiency and clean production, climate change, pollution, by sharing materials, energy or infrastructure.

One of the pioneer industrial estates in Indonesia is the Pasuruan industrial estate Rembang (PIER), established in 1992. This area is located in the Pasuruan district, East Java, Indonesia. Located on an area of 510 Ha, there are 85 industries, divided into three categories: food and beverage, chemicals, and manufacturing. PIER provides communal wastewater treatment facilities (WWTP) for

all industries in the PIER area, with a capacity of 28,000 m³.day⁻¹.

The PIER Industrial Estate, like other industrial areas with a negative impact on the community, has a negative impact on the surrounding community. Based on interviews and surveys conducted with the local government at the beginning of this study, it was discovered that there were public complaints about waste disposal as a result of industrial activities in the PIER Industrial Estate, such as odors and liquid waste.

Therefore, the sustainable development of the PIER industrial area is mandatory, because PIER is one of the national strategic industrial area, and also one of the areas that dominates Gross Regional Domestic Product (GRDP) from the industrial sector in East Java Province. The purpose of this article is to provide an assessment of the readiness of the Pasuruan Industrial Estate Rembang (PIER) to become a sustainable industrial estate based on the six principles of Lowe's EIP assessment.

MATERIALS AND METHODS

Research design

This research was conducted using qualitative methods with the type of research in the form of case studies. Research is designed using case studies because this research aims to describe an object. The object studied in this study is the PIER industrial estate where a description of the level of application of sustainable industrial principles will be carried out using the elaboration of the six main parameters of the Ernest Lowe (2001) concept, namely: (1) Integration between industries in the area with natural systems, (2) Sustainable use of energy and water, (3) Management of raw material flow and waste throughout the industry, (4) Effectiveness of area management. (5) Sustainable infrastructure construction design, and (6) Integration of industrial areas with surrounding communities, as shown in Figure 1.

The research data is in the form of questionnaire results obtained from the PIER industrial estate managers and industries located in the area. Research on managers and industries in the regions is being conducted to determine how far the implementation of EIP in the PIER Industrial Estates has been and can be carried out, related to the availability of supporting facilities for the implementation of EIP.

Research variable

The variables used to assess the readiness of PIER to become a sustainable industrial estate based on the six principles of Lowe's EIP assessment are described as follows:

- Integration between industries in the area and natural systems is the integration of the EIP area with the environment that takes into account the suitability of the environment where in selecting/ determining the location, an assessment of the carrying capacity of the environment must be carried out and the development of the area gives the least possible environmental impact.
- Sustainable use of energy and water is the use of energy and water systems that pay attention to efficiency in the use of energy in industrial areas, so that existing natural resources can be conserved as well as use of water that maximally utilizes water recycled.
- Management of the flow of raw materials and waste throughout the industry is the integration of material flow and waste management that emphasizes the application of clean production, prevention of pollution, minimizing the use of toxic materials. This level of integration is shown by the connection of industries in the EIP area in a symbiotic mutualism.
- Area management effectiveness is the level of effectiveness of EIP area management which takes into account the composition of the types of industry in the area so that a symbiotic mutualism can be developed between industries.
- Sustainable infrastructure construction design is a level of infrastructure development that pays attention to efficient use of materials and minimizes

pollution. The entire construction of the facility must be planned and designed to be strong, easy to maintain, and easy to change according to developments and when it is not used it is easy to recycle.

- Integration of industrial estates with surrounding communities is the level of integration of a sustainable industrial area with a well-developed surrounding community environment where the industrial area must provide benefits for the economic development of the surrounding community.

Based on the six previously described variables, a Likert scale of 1 to 3 was used to assess the level of application of EIP principles in the PIER industrial estate. The value of 1 indicates that the variable in question has been thoroughly implemented. A value of 2 indicates that it has been partially implemented, while a value of 3 indicates that it has not been implemented at all.

RESULT AND DISCUSSION

The assessment of the application of sustainable industry in PIER is carried out by assessing the current condition of the PIER industrial estate based on the six EIP Lowe principles criteria. The results obtained are as shown in Table 1. Based on the results of the assessment, it can be seen that the PIER industrial estate has implemented four EIP principles in the PIER Industrial Estate although not yet fully and the other two EIP principles have not been implemented at all. In this case, the four principles that have been implemented at PIER but have not been fully implemented are: the level of integration between the industrial area and the natural system, which is not integrated with the natural ecosystem. Initially, the developer of the PIER Industrial area had anticipated the possibility of environmental damage due to the activities carried out by the industry in the area by conducting an analysis of environmental impacts. However, no in-depth analysis was carried out on the possibility of waste generated by industrial activities. because there is no estimate. industries to be built in the area.

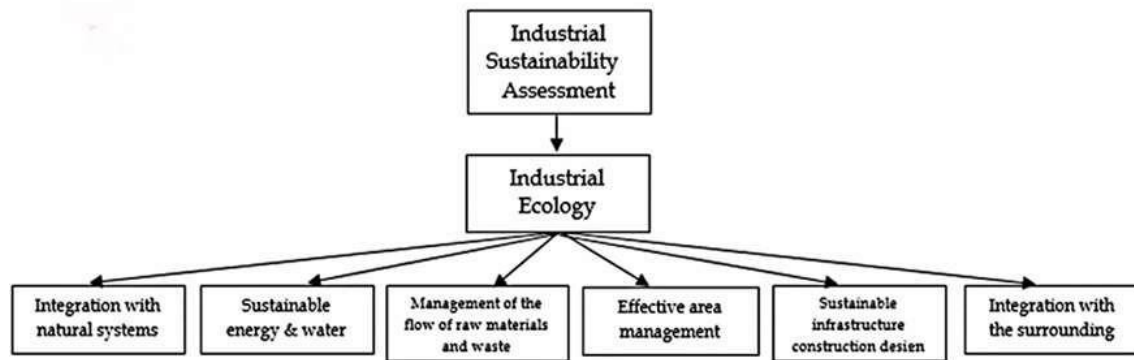


Figure 1. Sustainable Industry Assessment

Table 1. The Results of the Assessment of the Condition of the PIER Industrial Estate Based on the Sustainability Principle

No.	Criteria	Rating	Description
1.	The level of integration between industries in the area and natural systems a. Location and design according to carrying capacity b. Integration with natural ecosystems c. Integration and maintain the landscape	2	already but not yet fully implemented
2.	Sustainable use of energy and water a. Use of renewable energy b. Efficiency c. Energy integration between industries d. Water use efficiency	3	still not apply at all
3.	Management of raw material flow and waste throughout the industry a. The application of clean production b. By product exchange c. Integrated waste management	2	already but not yet fully implemented
4.	Area management effectiveness a. Environmental performance facilities b. Material flow exchange facility c. Integrated information system	2	already but not yet fully implemented
5.	Sustainable infrastructure construction design a. Green design b. Green construction c. Integrated utilization and management	3	still not apply at all
6.	Integration of industrial estates with surrounding communities a. Multiplier effect b. Human resource capacity building for workers and the surrounding community c. Facilitate the improvement of the physical environment performance in the surrounding area	2	already but not yet fully implemented

Based on these results, it can be concluded that the application of sustainable principles in the PIER Industrial

Estate is currently categorized as not yet fully implemented. In addition, in the PIER Industrial estate, there is also no symbiotic

relationship between each industry. One example of the success of EIP which has proven to be able to reduce environmental impacts and result in saving natural resources and energy is the industrial area of Kalundborg, Denmark. Through the implementation of EIP, the Kalundborg industrial area annually saves water, energy/fuel, and the use of chemicals, as well as reduces negative impacts on the environment through waste exchange activities, the substitution of raw materials and reuse of production wastewater carried out by industries in the area.

From the results of the assessment, to realize a sustainable Industrial Estate, PIER needs to take one first step, by implementing a symbiotic mutualism between industries or often also called waste exchange. This concept is the most commonly known concept in industrial ecology where in this concept companies in industrial areas try to make maximum use of the resources available in the area before taking resources from outside.

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