PAPER • OPEN ACCESS

Driving factors for the success of the green industrial estate: a case study of Pasuruan Industrial Estate Rembang

View the article online for updates and enhancements.

Driving factors for the success of the green industrial estate: a case study of Pasuruan Industrial Estate Rembang

H Nainggolan[1], N W S Wardhani[2], A S Leksono[2] and I Santoso[3]

[1] Postgraduate School, Universitas Brawijaya, Malang, Indonesia
[2] Faculty of Mathematics and Natural Sciences, Universitas Brawijaya, Malang, Indonesia
[3] Faculty of Agricultural Technology, Universitas Brawijaya, Malang, Indonesia

E-mail: hotnida.ustj@gmail.com

Abstract. The concept of green industry became a hot issue all over the world as a result of scarcity of resources and environmental quality degradation. Several developed and developing countries have obligated the implementation of the green industry. Indonesian government through the Ministry of Industry also strives to implement green industry principles by adding green industrial standards through law number 3/2014. Pasuruan Industrial Estate Rembang (PIER) is one of the developing industrial estates in East Java, Indonesia. This paper aims to map out the key factors of environment management that make up a green industrial estate (GIE) in PIER. Data was collected by questionnaire, interview, observation, and documentation. The interview was done with experts from PIER management and several industries in the region and also the local government in Pasuruan Regency who understand and are related to this research. The methods used are the Delphi technique survey, the average descriptive statistical and the Analytical Hierarchy Process (AHP) to determine the priority factors for the success of the GIE perspective. As a result, success factors in developing green industrial areas must be supported by several factors, including: clean technological innovation; waste management, operational standard systems; sustainability of Corporate Social Responsibility (CSR); availability of energy, raw materials, water, infrastructure and technology; and the existence of legal certainty and security are the main important factors in driving the success of industrial estates into green industrial estates.

1. Introduction

Industrial activity has a role in economic growth, but on the other hand, it also leads to environmental damage. The world's awareness of the environment is now increasing, this can be seen from the tendency of the world community to choose environmentally friendly products (green labelled). This encourages industrial estates to make innovations in order to remain competitive in the international market. A concept to minimise environmental damage and harmonize between economic growth and environmental sustainability, is known as the green industry. The green industry is an industry that in its production process prioritises efforts to efficiency and effectiveness in the use of resources in a sustainable manner to be able to align industrial development with the preservation of environmental functions and can provide benefits to the community. Green industry encourages industrial companies to make continuous improvements in all lines in order to improve the efficiency and effectiveness of production which has a big impact on industrial companies [1].

Several research on the implementation of the concept of the GIE in Indonesia have been done. In the last ten years, in general, has not shown a significant development with the average being in a less green status, including: Prasetya who measured the status of 13 pioneer industrial zones in several regions in Indonesia [2], Sunarjo in the Jababeka industrial estate [3], Sulaiman in Cilegon industrial estate [4], Kodrat in Medan industrial area [5], Susanti in Semarang industrial estate [6], and Budiyanto in the Jakarta industrial area east Pulogadung [7].

To anticipate the intense environmental issues in international trade and to keep national industries competitive, the Ministry of Industry Republic of Indonesia has responded that issue by putting the green industry as an important part of Master Plan of National Industry Development 2015–2035. To encourage industry in implementing green industry principle, since 2010 Ministry of Industry has conducted Green Industry Award. Although each year, there is an increasing number of award receivers, but comparing with the total numbers of industries in Indonesia, the percentage of award receivers is so small.

At the global level, several studies related to green industrial areas have been carried out. The Sustainable Development Goals (SDGs) program states that important sector activities in development must adopt a commitment to ecological protection and reduction of waste that has an impact on the environment [8]. Conticelli and Tondelli, starting in the early 1990s, the concept of green industry began to be adopted by developed countries such as several industrial zones in the US state; Brownsville in Texas, Cabazon Park in California, and several industrial estates in the European Union such as Danish Kalundborg, Green Park Cronwall UK and Emscher Park Germany [9]. In Asia, the application of green industry starts from China, Korea and Japan [10]. According to Tessitore et al. [11], one of the basic principles of implementing the green industry adopted by many industries in several countries is the concept formulated by Lowe. Green transformation refers to processes within industries that lead to reduced environmental change impact [12]. Masoumik et al. [13] conducted a green strategy performance analysis on environmental performance and competition in the ISO14001 EMS certified industry in Malaysia. The results show that clean technology has the biggest impact on increasing competition, which is followed by product management and pollution prevention.

This research was conducted in the industrial estate considering that the industries in the region have the potential to cause ecological, economic and socio-cultural changes in the surrounding environment. In addition, there are rules that all manufacturing industry activities in Indonesia must be located in the industrial estate [14]. PIER was chosen as the focus of research because it is in line with PIER's vision to become a modern integrated and environmentally friendly industrial estate. Also, currently PIER plans to develop PIER II, which is located near the PIER location. Until now there has been no research to identify important factors in driving success in developing green industrial areas in Indonesia. Studies that have been conducted lately are generally about the measurement or assessment of green industries. Therefore, the present study aimed to investigate important factors that drive the development of GIE.

2. Research Methods

This research was conducted at PIER, which is one of the developing industrial estates in Pasuruan, East Java, Indonesia, located on an area of ± 510 Ha (Figure 1). There are 77 industries of various types, which can be classified into three groups: the food and beverage industry, the chemical industry and manufacturing. PIER is a further development of PT. SIER. The first industrial estate development was carried out in Surabaya, namely Surabaya Rungkut Industrial Estate (SIER), then followed by Sidoarjo Industrial Estate Berbek (SIEB) and the third was Pasuruan Industrial Estate Rembang (PIER). PIER is the largest industrial estate among the three regions. PIER provides communal wastewater treatment (WWTP) facilities for all industries in the PIER area, with a capacity of 28,000m^3/day, which is the largest in East Java.

Figure 1. Pasuruan Industrial Estate Rembang Map [16]

2.1. Method of data collection

This study used qualitative and quantitative methods that combine confirmatory and exploratory data [15]. In the initial stages of determining the variable and indicator of GIE comes from secondary data and then confirmed by primary data input from experts through questionnaires (expert surveys), in-depth interviews and focus group discussion (FGD) with predetermined samples / chosen deliberately (purposive sampling).

The data source of this study consisted of primary and secondary data. To obtain primary and secondary data, the following data collection methods were used:

a. Survey method, by making observations on the object of research to get a clear picture of environmental performance in PIER. Besides, the survey was also conducted by asking respondents to fill in research instruments in the form of questionnaires that have been prepared.

b. The selected interview method is semi-structured by conducting a question and answer with respondents using a list of questions that have been prepared. At the same time, it allows researchers to respond to respondents' answers to develop and explore as deeply as possible the factors that drive the successful to be the green industrial estate.

c. Secondary data were obtained through the study of documents relating to the object of research. This data was obtained from relevant sources: industrial estate, industrial tenants, journals, and official publications from related institutions.

The variables and indicators used in this study are elaborated from the assessment of green industry awards issued by the Indonesian Ministry of Industry. There are three variables: the production process, the performance of waste / emissions management, and company management [17]. Another variable, namely: government policy was added. This is based on the results of surveys and interviews with experts and literature studies related to this research. According to Leitch et al. [18], government policies is an integral part of the corporate environment, because as a regulatory body the government has a significant role in the policies made by companies in the external environment. In line with this statement Henriques and Sadorsky [19] also explained that government policy has an influence on the management of a company. The government as one of the components

of the company's stakeholders causes its role in the company's activities to be very important. Each of these aspects consists of several indicators whose importance is assessed based on factual data from the industry determined as a sample.

2.2. Method of data analysis
The methods used are the Delphi technique survey, the average descriptive statistical and the Analytical Hierarchy Process (AHP). Delphi method is used to obtain data related to important factors needed for the development of the green industrial estate. This method approach is applied through interviews, discussions, and brainstorming. The results of the Delphi method are then analysed with a descriptive statistical approach to determining the average value based on the respondent's perceived value [20]. Descriptive statistics in the form of the average value is a comparison between the total values of the variable with the number of observations. AHP method is used to analyse the priority setting of important factors that will be used in the successful development of a GIE (Figure 2).
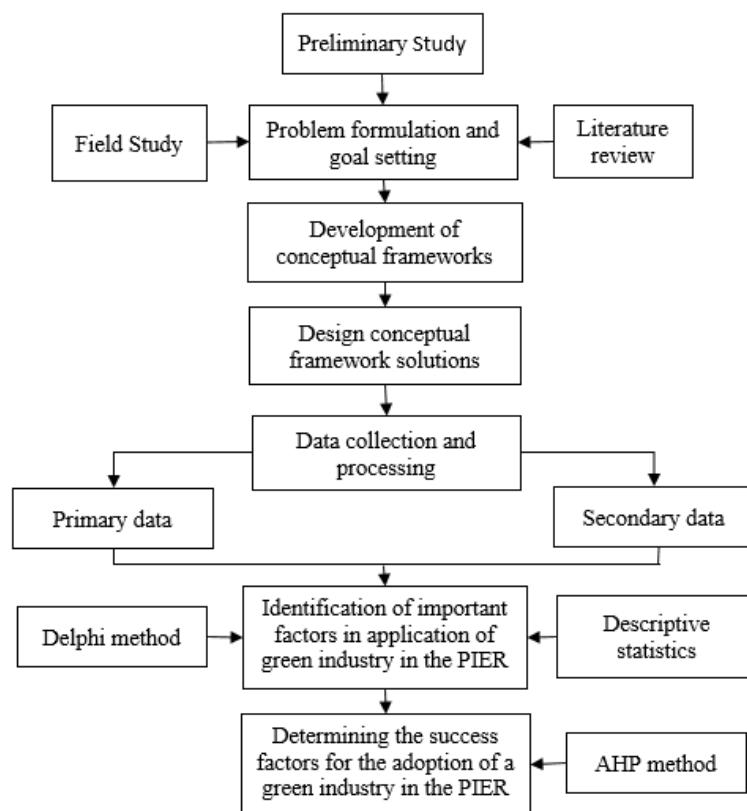

Figure 2. Research framework diagram

3. Results and Discussion
Determination of the factors for the success of the green industrial estate in the research area is carried out by using green indicators that have been produced through literature studies and expert consultations. There are 17 indicators that are important factors in developing a green industrial area, including 7 indicators of the production process, 3 indicators of Waste / Emission Management Performance, 4 indicators of Company Management and 3 indicators for Government policy. By using descriptive statistics, the average value of the comparison is obtained between the total value of the variable and the number of observations (Table 1).

3.1. The results of the weighting of important factors using the Delphi technique
Table 1 shows, all the factors mentioned tend to be important and needed in the success of GIE development because they all have an average value > 7. Although the value does not indicate a significant difference, each variable has the highest value that can be interpreted as the most important factor. For the production process variable (X1), the most important factor is technological innovation. This confirms the results of research from Missoumick [13] which shows that clean technology has the most significant impact on increasing green strategy competition on environmental performance and this is in line with Law No. 3/2014 that the concept of green industry uses low carbon technology. The use of low-carbon technology will have the effect of saving energy, water and raw materials, and will increase productivity and produce less waste.

Table 1. Average value of important factors

Variables	Important Factors	Code	Average
Production process (X1)	Production efficiency program	(X1.1)	8.2
	Material Input quality (certified)	(X1.2)	7.9
	Energy efficiency & renewable energy	(X1.3)	8.1
	Water management	(X1.4)	7.7
	Technological innovation	(X1.5)	8.7
	Human Resources	(X1.6)	8.3
	Work Environment safety	(X1.7)	7.8
Waste / Emission Management Performance (X2)	GHG emission reduction programme	(X2.1)	7.8
	Fulfillment of Environmental Quality Standards	(X2.2)	8.2
	Waste/Emission Management Facilities	(X2.3)	8.8
Company Management (X3)	Operational Standards/management system	(X3.1)	8.4
	Corporate Social Responsibility (CSR)	(X3.2)	8.3
	Award environmental production and management	(X3.3)	7.7
	Employee health (medical check-up)	(X3.4)	7.3
Government policy (X4)	Availability (energy, raw material, water, infrastructure, technology)	(X4.1)	8.8
	Certainty (security, legal)	(X4.2)	8.5
	Incentives (tax, investment	(X4.3)	8.2

The most important factor of waste / emission management performance (X2) is the waste / emission management facility, which means the industry needs to have a waste treatment facility that is suitable for the type of waste and emissions it produces to develop into a green industrial estate. The company management (X3) has operational standards / management system as the most important factor in the successful development of a GIE. Operational standards aim to provide product quality assurance to consumers in accordance with applicable technical specifications. Product certification can refer to applicable National and International Standards. Operational standards aim to provide product quality assurance to consumers in accordance with applicable technical specifications. Product certification can refer to applicable National and International Standards. This means that product quality assurance is very important for GIE. The analysis of government policy aspect (X4) shows that the availability of facilities and infrastructure in the form of energy, raw materials, water, technology, is very important to realize a GIE.

3.2. Priority weighting and ranking of the main important factors using AHP analysis

Related to prioritisation of important factors that drive the development of green industrial estates, the order is first determined. The results of AHP analysis using Expert choice 9.0 software are shown in Table 2. Based on these results, there are several factors which together become the first priority factor, namely technological innovation, waste/emission management facilities, operational standards / management system, corporate social responsibility (i.e. CSR), availability (i.e. energy, raw material, water, infrastructure, technology) and certainty (i.e. security, legal). This is in line with the principles of the world industrial organisation (UNIDO) which states that the green industry is an approach that is oriented towards increasing efficiency through economic steps in the use of materials, water and energy; alternative energy use; the use of materials that are safe for humans and the environment; and the use of low-carbon technology with the aim of increasing productivity and minimising waste that emphasises a business approach to providing increased economic and environmental efficiency [21].

Table 2. Weighting and ranking of the main important factors

Variable	Important Factors	Code	Weight	Ranking
Production Process (X1) 0,2	Production efficiency program	(X1.1)	0,184	2
	Material Input quality (certified)	(X1.2)	0,118	3
	Energy efficiency & renewable energy	(X1.3)	0,184	2
	Water management	(X1.4)	0,079	5
	Technological innovation	(X1.5)	0,293	1
	Human Resources	(X1.6)	0,087	4
	Work Environment safety	(X1.7)	0,055	6
Waste / Emission Management Performance (X2) 0,3	GHG emission reduction programme	(X2.1)	0,191	3
	Fulfilment of environmental quality standards	(X2.2)	0,311	2
	Waste/Emission Management Facilities	(X2.3)	0,498	1
Company Management (X3) 0,2	Operational Standards/management system	(X3.1)	0,351	1
	Corporate Social Responsibility (CSR)	(X3.2)	0,351	1
	Award environmental production and management	(X3.3)	0,189	2
	Employee health (medical check-up)	(X3.4)	0,109	3
Government policy (X4) 0,3	Availability (energy, raw material, water, infrastructure, technology)	(X4.1)	0,398	1
	Certainty (security, legal)	(X4.2)	0,398	1
	Incentives (tax, investment, promotion)	(X4.3)	0,204	2

4. Conclusions

Based on the objectives of this study, it can be concluded that the important factors identified as successful in driving a green industrial area are: clean technology factors; waste management, operational standard systems; CSR sustainability; availability of energy, raw materials, water, infrastructure and technology; and security and legal certainty. So, the most important factor in driving the success of an industrial zone into a green industrial zone is not only determined by one factor but by several factors that are just as important.

References

[1]   Lowe, Ernest A 2001 Eco-industrial park handbook for asian developing countries. Report to
         Asian Development Bank Environment Department Oakland.

[2]   Prasetya H 2007 Pengukuran status kawasan industri terhadap konsep eco industrial park (Measurement of the status of industrial estates on the concept of eco industrial park) *J. Tek. Lingk.* **8** 1 8-16. [In Indonesian]

[3]   Sunarjo L 2007 Kajian pengembangan eco industrial park (Study on eco industrial park development) Proceedings Innovation in Environmental Management Diponegoro University and Queensland University [In Indonesian]

[4]   Sulaiman F, Asep S, Rizal S, Alinda F M Z 2008 Strategi pengelolaan kawasan industri Cilegon menuju eco industrial park (Strategies for the management of the Cilegon industrial area towards an eco industrial park) *Jurnal Perencanaan Wilayah dan Kota* **19** 2 35-57. [In Indonesian]

[5]   Kodrat K F 2011 Analisis sistem pengembangan kawasan industri terpadu berwawasan lingkungan (studi kasus di PT. Kawasan Industri Medan) (Analysis of an integrated industrial estate development system with an environmental perspective (case study in PT. Medan Industrial Estate)) *Jurnal Manusia dan Lingkungan* **18** 2 146-158. [In Indonesian]

[6]   Susanty A, Puspitasari N B, Sipayung D L 2015 Usulan pengembangan eco industrial park dengan konsep *waste exchange* (Proposed development of eco industrial park with the concept of waste exchange) Proceeding of Seminar Nasional IENACO Surakarta 2015 P315 [In Indonesian]

[7]   Budiyanto P, Saefuddin A, Putri E I K 2015 Analisis keberlanjutan PT East Jakarta Industrial Park dalam mewujudkan kawasan industri yang berwawasan lingkungan (Analysis of the sustainability of PT East Jakarta Industrial Park in realizing an environmentally friendly industrial estate) *Jurnal Pengelolaan SDA dan Lingkungan* **5** 2 199-209. [In Indonesian]

[8]   United Nations 2015 Transforming our world: the 2030 agenda for sustainable development. Report of the Open Working Group of the General Assembly on Sustainable Development Goals **70** 1-35.

[9]   Conticelli E, Tondelli S 2014 Eco-industrial parks and sustainable spatial planning: a possible contradiction? *J. Adm. Sci.* **4** 331–349.

[10] Tian J, Liu W, Lei B, Li X, Chen L 2013 Study of the performance of eco-industrial parks development in China *J. Clean. Prod.* **64** 486-494.

[11] Tessitore S, Daddi T, Iraldo F 2015 Eco-industrial parks development and integrated management challenges: finding from Italy *Sustain.* **7** 10036-10051.

[12] G A (Growth Analysis) 2014 Prerequisites for a green structural transformation of Swedish industry-shynthesis report. Report the Swedish agency for Growth Policy Analysis Ostersnd.

[13] Masoumik S M, Hanim S, Abdul-Rashid, Olugu E U 2015 Importance-performance analysis of green strategy adoption within the malaysian manufacturing industry *Procedia CIRP* **26** 646 – 652.

[14] Peraturan pemerintah Republik Indonesia nomor 142/2015 tentang kawasan industri (Republic of Indonesia government regulation number 142/2015 regarding industrial estate) [In Indonesian]

[15] Sugiyono 2016 Metode penelitian kombinasi (Mixed methods of research) Alfabeta. [In Indonesian]

[16] Annual Report of PT. Surabaya Industrial Estate Rungkut (SIER) 2016 p284 [In Indonesian]

[17] Pusat Penelitian dan Pengembangan Industri Hijau 2018 Pedoman penilaian penghargaan industri hijau (Green industry award assessment guidelines) Kementerian Perindustrian Jakarta. [In Indonesian]

[18] Leitch R R, Shen Q, Coghill G M, Chantler M J 1999 Choosing the right model *IEE Proceed. Cont. Theory Appl.* **5** 435-449.

[19] Henriques I, Sadorsky P 1999 The relationship between environmental commitment and managerial perceptions of stakeholder importance *Acad. Manage. J.* **42** 1 87-99.

[20] Skulmosky G, Hartman F T and Krahn J 2007 The delphi method for graduate research *J. Inf. Technol. Ed.* **6** 1-21.

[21]   United Nations Industrial Development Organization (UNIDO) 2011 UNIDO green industry policies for supporting green industry United Nations Vienna.