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**Design of Green Industry Performance Measurement and
Evaluation Systems**

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Abstract

Sustainability become the target of long-term development in national industry. One of efforts in order to sustain the industry is by applying the concept of green industry that is part of Industrial Ecology. This study aims to design system of measurement and performance evaluation of green industry. Weighting aspect and KPI (Key Performance Indicator) based on the Guidelines of Green Industry Reward from the Ministry of Republic of Indonesia. The results of the analysis of 3 aspects, namely the production process, performance of waste/emissions management, and company management, that based on the strategic objectives of each aspect, the number of KPIs is obtained in a row, namely the production process of 26 KPIs, the performance of waste/emissions management of 5 KPIs, and company management 8 KPIs, so that from all aspects obtained 39 KPIs. Furthermore, each aspect and KPI is weighted as a basis for measuring and evaluating its performance.

Keywords: Green Industry; Performance; Industrial Ecology; KPI; Design.

1. Introduction

Economy, social and environmental sustainability become the target of long-term development in national industry. One of efforts in order to sustain the industry is by applying the concept of green industry that is part of Industrial Ecology. Green industry leads to production pattern and sustainable consumption that is the efficient use of resources and energy, low carbon and low waste, no pollution and safe pattern, as well as producing products that can be managed in a responsible way along its life cycle [1,21].

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Design of Green Industry Performance Measurement and Evaluation Systems

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Abstract

Sustainability become the target of long-term development in national industry. One of efforts in order to sustain the industry is by applying the concept of green industry that is part of Industrial Ecology. This study aims to design system of measurement and performance evaluation of green industry. Weighting aspect and KPI (*Key Performance Indicator*) based on the Guidelines of Green Industry Reward from the Ministry of Republic of Indonesia. The results of the analysis of 3 aspects, namely the production process, performance of waste/emissions management, and company management, that based on the strategic objectives of each aspect, the number of KPIs is obtained in a row, namely the production process of 26 KPIs, the performance of waste/emissions management of 5 KPIs, and company management 8 KPI, so that from all aspects obtained 39 KPIs. Furthermore, each aspect and KPI is weighted as a basis for measuring and evaluating its performance.

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1. Introduction

Economy, social and environmental sustainability become the target of long-term development in national industry. One of efforts in order to sustain the industry is by applying the concept of green industry that is part of Industrial Ecology. Green industry leads to production pattern and sustainable consumption that is the efficient use of resources and energy, low carbon and low waste, no pollution and safe pattern, as well as producing products that can be managed in a responsible way along its life cycle [1,21].

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Green industry program in Indonesia is the selection of industry that environmentally friendly that has made an effort to manage the living environment so that it can minimize pollution and living environment degradation as a consequence from industrial activity, given top priority on efficiency and effectiveness of the use of natural resources and it can be beneficial for the society [2]. Previous studies on the green industry, sustainability and performance measurement systems have been widely conducted. Shapira and his colleagues [3] said that an increasing interest for sustainability innovation and development of green industry and environmentally friendly jobs in UK. According to Atmawinata [4], the concept of green industry is not only relevant to the development of industry which is environmentally friendly but also it relates to the implementation of the integrated, holistic and efficient industrial system. The concept of the green industry also gave rise to various studies, including in manufacture thus it is known as sustainable manufacturing system. Negulescu [5] in his study about contribution of green industry discuss about improving global business environment, producing conceptualize of investment process in green industry and increasing process of global business environment with investment in green industry. A number of large companies and corporates have changed the development strategy towards green industry. Characteristic of *Green Industry* according to Dewi and Siagian [6] are: (1) the use of raw materials which is environmentally friendly, (2) efficiency in using raw materials, (3) applying 4R program (*reduce, recycle, reuse and recovery*), (4) efficiency in using energy and water (5) minimalizing waste arising and (6) using low carbon technology. The result of research which has been done by Chen and his colleagues [7] showed that level of green industry development in China has the characteristic of typical specific regional differentiation with distribution as households from east and central to the west, and the eastern region has the highest degree on the output, efficiency and innovation of green industry. While Negulescu [5] showed the conceptualization of investment process in green industry and process of enhancing the global environment business with green industry investment. The application of green industry practices is very beneficial for every component of the earth's system [13]. Su and his colleagues [17] to measure the level of industrial development of the three aspects of Chinese green production. Meanwhile, Lu and his colleagues [18] apply the model of decoupling to develop green industry evaluation index system and measuring the level of development. Performance measurement is a management tool used to improve the quality of decision making and accountability. Performance measurement is also used to assess the achievement of goals and objectives [8]. In a performance measurement system a large number of multidimensional factors can affect performance [15,16]. Neely and his colleagues [9] defines performance measurement as the process of quantifying the efficiency and effectiveness of action, and performance measurement system as the set of metrics used to quantify the efficiency and effectiveness of an action. The company must strive to continuously improve its performance [12]. Increasing industrial sustainability performance is very important [10], one of which can be through improving the performance of green industry. Kolomeytseva [19] use correlation analysis to compare the GIP (Green Industrial Performance) scores with UNIDO's competitive industrial performance index and conclude that the progress in the greening of the manufacturing industry will contribute to the improving the industrial competitiveness of the EAEU countries. Hashim et. al. [20] propose a new systematic tool, known as Green Industrial Performance Scorecard (GIPS) to create green industry profiling besides highlighting the potential improvement of green performance through visualisation. Several previous studies on green industry, sustainability, performance measurement and evaluation have been carried out as described above, but most of them are still carried out partially. This study tries to combine and design a green industrial performance

measurement system for the sustainability of the national industry. Therefore, the aim of the study is to design measurement and evaluation performance system of green industry, and determine the weighting aspect and Key Performance Indicator (KPI). The result of designing measurement and performance evaluation system of green industry can be a mean for measuring and evaluation performance of green industry on subsequent research, in order to enhance the performance of the sustainability of manufacturing industries.

2. Methods

The study is started by identifying aspect and criteria of green industry performance. Next step is designing the system of measurement performance by using an approach on assessment guidebook designed by Ministry of Industry of Republic Indonesia [11] which is covering the strategic objective in every performance aspect and criteria of green industry, the determination of successful measurement indicator (KPI), and weighting of every performance aspect and criteria, and also KPI. The determination of KPI is a very important part in designing performance measurement system [10,12,14]. KPI can be broken down form strategic objective and document tracing that explain about green industry system. An understanding of the whole green industry system is useful as a basis for identifying proper KPI. Next, each KPI that has been identified is arranged in hierarchical structure to distinguish the position of a KPI in other KPI. Weighting method of aspect and KPI is based on the Green Industry Reward Guidelines from the Ministry of Republic of Indonesia.

3. Analysis and Discussion

3.1. Identification of Aspect and Criteria of Green Industry Performance

Identification that has been carried out can be produced 3 aspects or criteria that are production process aspect, emission/waste management performance aspect, company management aspect. Aspect of production process consists of 7 sub aspects that are production efficiency program, material input, energy, water, the process of technology, human resources, and workplace environment in the production process room. Aspect of waste/emission management performance consists of 3 sub aspects that are low emission program of Green House Gases, fulfillment of raw quality environment, and the means of emission/waste management. In addition, company management aspect consists of 4 sub aspects that are operational standard, CSR, reward, and employees' health.

3.2. Designing Measurement and Evaluation of Green Industry Performance System

The result of strategic objective determination and each aspect of KPI and sub aspects is obtained that the aspect of production process produces 26 strategic objectives and 26 KPI, aspect of waste/emission management performance produces 5 strategic objective and 5 KPI, and aspect of company management produces 8 strategic objectives and 8 KPI, thus overall, it can be obtained 39 strategic objectives and 39 KPI. Based on the result of the common design of measurement performance system in green industry, for further step it can be created hierarchical structure of KPI as shown in figure 1. In figure 1 hierarchical structure of KPI and green industry performance show that hierarchical structure is arranged from aspect, sub aspect, and KPI. Green industry performance is measured from every aspect and sub aspect through every KPI performance in advanced study.

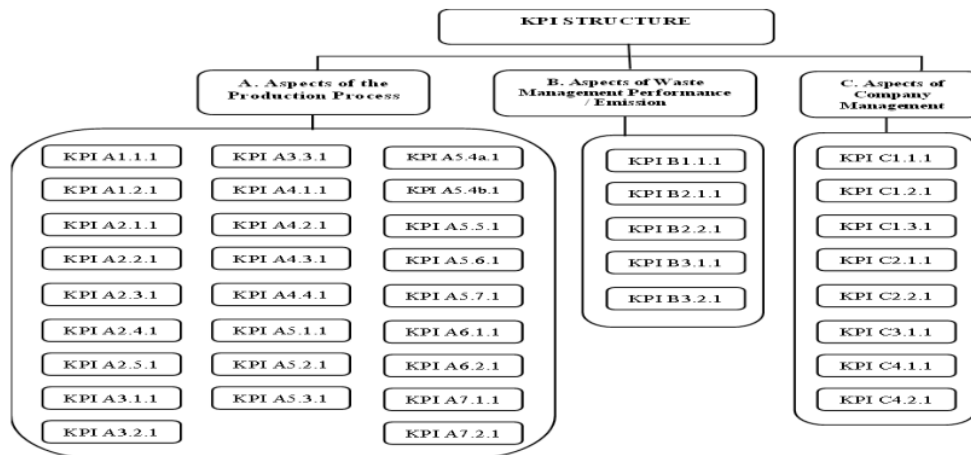


Figure 1: Structure of KPI Performance of Green Industry.

Table 1

No	KPI	Description
1	KPI A1.1.1	: There is commitment, planning, implementation, monitoring / evaluation of production efficiency programs by top management
2	KPI A1.2.1	: Achievement level of production efficiency programs implementation
3	KPI A2.1.1	: Percentage of input material used has a certificate / permit
4	KPI A2.2.1	: Percentage of the product to the input material
5	KPI A2.3.1	: The efficiency level of using input material
6	KPI A2.4.1	: The level of input material substitution
7	KPI A2.5.1	: The level of material input handling includes: (1) placement in a special warehouse / room, (2) quality monitoring, (3) application of the FIFO (First in First Out) principle, and (4) separation based on material type
8	KPI A3.1.1	: The level of energy efficiency (energy index reduction)
9	KPI A3.2.1	: The ratio of renewable energy use to total energy use
10	KPI A3.3.1	: Frequency of energy management activities
11	KPI A4.1.1	: The level of water use efficiency (<i>water index reduction</i>).
12	KPI A4.2.1	: The level of recycled water use for the production process and / or utility
13	KPI A4.3.1	: There is effort to conserve water sources
14	KPI A4.4.1	: Frequency of water management activities
15	KPI A5.1.1	: The level of implementation of Reduce, Reuse, Recycle and Recovery (4R)
16	KPI A5.2.1	: There is segregation of wastewater from production processes, domestic wastewater and rainwater. Wastewater from the production process is treated in WWTP (Waste Water Treatment Plant) separately from domestic wastewater and rainwater
17	KPI A5.3.1	: There is innovation of process technology that include replacement and modification of machine / equipment
18	KPI A5.4a.1	: The level of Overall Equipment Effectiveness (Batch system)
19	KPI A5.4b.1	: The level of Overall Equipment Effectiveness (Continuous system)
20	KPI A5.5.1	: SOP (Standard Operating Procedure) application amount of input material handling, production processes, and maintenance
21	KPI A5.6.1	: The level of product innovation (patents, commercial, testing, study, none)
22	KPI A5.7.1	: The level of reject product to total product
23	KPI A6.1.1	: The level of human resource capacity of production process that meets external and internal requirements
24	KPI A6.2.1	: Percentage of human resources who have received competency training
25	KPI A7.1.1	: The frequency of monitoring and performance assessment program of Occupational

No	KPI	Description
		Safety and Health of Work Environment in accordance Minister of Manpower Regulation
26	KPI A7.2.1	: Percentage of employees enrolled in Social Security for Employment
27	KPI B1.1.1	: The percentage of GHG (Greenhouse Gas) emission reduction
28	KPI B2.1.1	: The level of compliance with Environmental Quality Standards in liquid waste
29	KPI B.2.2.1	: The level of compliance with Environmental Quality Standards for waste of gas and dust
30	KPI B3.1.1	: The level of completeness and operation of waste and emission management facilities (according to applicable requirements)
31	KPI B3.2.1	: There are facilities, can operate and have a license
32	KPI C1.1.1	: Percentage of certified products
33	KPI C1.2.1	: Increasing the application of the Management System which includes planning, implementation, monitoring and evaluation and action plans
34	KPI C1.3.1	: The number of international standard certification of organization owned
35	KPI C2.1.1	: The level of implementation of sustainable Corporate Social Responsibility (CSR) includes the implementation, monitoring and evaluation and there is reporting
36	KPI C2.2.1	: Number of sustainable CSR programs
37	KPI C3.1.1	: The number of awards related to the field of production and environmental management industry has ever received in the last period of 1 year
38	KPI C4.1.1	: The frequency of periodic medical check-ups for employees
39	KPI C4.2.1	: Percentage of employees enrolled in health social security

3.3. Determination of Weight Aspect and Key Performance Indicator (KPI)

Weighting aspect and KPI based on the Green Industry Reward Guidelines from the Ministry of Republic of Indonesia that is obtained that weight of the production process is 70% or 0.7, thus weight of each KPI on aspect of production process is 2.69 % or 0.0269. The weight of waste/emission management performance is 20% or 0.2, thus weight of each KPI on waste/emission management performance is 4% or 0.040. Furthermore, weight of company management aspect is 10% or 0.1, thus weight on each KPI on company management aspect is 1.25% or 0.0125.

4. Conclusions

Based on the result of analysis there are 3 aspects or green industry performance criteria that are aspect of production process, aspect of emission/waste management performance, and aspect of company management. Aspect of production process consists of 7 sub aspects, aspect of waste/emission management performance consists of 3 sub aspects, and aspect of company management consists of 4 sub aspects.

Design of measurement and performance evaluation system of green industry include the determination of strategic objective, determination of KPI and weighting. The result of KPI determination based on strategic objective from each aspect is obtained that aspect of process production produces 26 KPI, aspect of waste/emission management performance produces 5 KPI, and company management aspect earns 8 KPI, therefore, overall result obtains 39 KPI. The biggest number of sub aspects and KPI is on the production process. The weight that is obtained from aspect and KPI is the weight from aspect of production process that is 70% or 0.7, thus the weight of every KPI is 2.69% or 0.0269. The weight of aspect of waste/emission management performance is 20% or 0.2, thus the weight of each KPI is 4% or 0.040. Furthermore, the weight of

company management aspect is 10% or 0.1, thus the weight of each KPI is 1.25% or 0.0125. Therefore, the biggest weight aspect is production process aspect, while the biggest weight of KPI is aspect of waste/emission management performance.

5. Limitations

The limitation of this study is on the availability of data because there are relatively few industries participating in the green industry awards event held by the Ministry of Industry of the Republic of Indonesia compared to the number of industries in Indonesia. This study is still early to design a green industry performance measurement system as a tool for measuring and evaluating the performance of green industries, so further studies are needed on the measurement and evaluation of green industry performance in Indonesia.

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