Identification of factors affecting a green industry: a literature review

Sophia Aryani Siregar*, Humala Napitupulu and Rosnani Ginting

Magister of Industrial Engineering, Department of Industrial Engineering, Faculty of Engineering, Universitas Sumatera Utara, Medan, 20155

*Email: sophiaaryanisiregar@gmail.com

Abstract. The definition of the green industry, sustainable industry or other definitions have a diverse definition, so that this term has a comprehensive dimension. The concept of the green industry is not only focused on eco-friendly industrial development, but also in the implementation of integrated, holistic, effective and efficient industrial systems. The development of the green industry concept creates numerous studies, including in the manufacturing world, and it is known as sustainable manufacturing. The International Standard Organization (ISO) as an international institution on standardization also encourages every company to have a balance focused on sustainable growth, environment, and community welfare (sustainable) which is covered by ISO 9000, ISO14000, and ISO 26000. The objective of this research is to expose and clarify the factors that may affect the green industry. Factors affecting the variables can be analyzed to facilitate the implementation of the green industry concept in the industrial world. The stages of this research include several steps, i.e. in the early stages, conduct the collection of regulations, articles, and journals, and then create a resume and classify these factors. The most common factors are waste, energy consumption, and water utilization.

1. Introduction
The industry is an economic activity that produces goods or services, consisting of the primary industries (raw materials/ pre-processing industries), secondary industries (industries that process raw materials into other goods/the process of manufacturing), and the tertiary industry (providing services) [1]. The industrial world in its production process will consume limited availability of natural resources and continue to diminish. The influence of globalization and extreme climate change has resulted in the greenhouse effect also contributed by the industrial world [2, 3, 4]. The earth will receive heavy burdens due to the unwieldy use of natural resources, an increased amount of irreducible waste and increasingly widespread environmental pollution resulting in significant damage and natural change rapidly bring adverse impacts for humans, such as environmental damage, global warming, the ozone layer holes, and other natural changes [5, 6, 7].

Besides the development of the trend of green consumers that are conscious and more selective in consuming non-environmental products, it will force the industry to use alternative resources and take into account the environmental aspects production to keep its products in demand by consumers [8]. In addition, there are existence of regulations and issues to the environmental aspects (the issuance of The Republic of Indonesia Law No. 32 the year 2009 on Protection and Management of the Environment) and also the increasingly stringent business competition, then the need to enhance the higher competitiveness capabilities with low environmental impacts pushing the industry on a paradigm known as the green industry [9, 10]. Environmental issues pertaining to the scarcity of
natural resources, global warming, waste management, and increasingly stringent environmental regulations are the challenges that must be faced by the industrial world as well as the competition, rapid and dynamic change of business environment [11].

The green industry [1] is considered as an industry that encourages sustainable production and consumption patterns, namely energy and resource efficiency, low-carbon and low-waste, without pollution and safety and produces environmentally friendly products. The United States through the US Bureau of Labor & Statistics defines the green industry as an industry that produces both goods and services that are beneficial for the environment, or resource conservation, or involving environmentally friendly production processes, or focus on the efficiency of natural resources.

The green Industry is an industry that in its production process prioritizes the efficiency and effectiveness of sustainable use of resources, to align with the industrial development with the sustainability of environmental functions [12]. The green Industry focuses on the use of good resources, the efficiency of raw materials, energy, waste, carbon management, and even transportation becomes the main thing, besides the use of alternative energy that produces less carbon [13, 14]. Through the application of the green industry, will occur the efficiency of the use of raw materials, energy and water, so that the waste or emissions produced will be minimized, and the production process more efficiently which enhances the competitiveness of the national industrial products.

2. Research method
Identification is a stage or process of formulating something to identify problems to be resolved. An easy way to identify is to clearly understand problems that need to be addressed. The way to identify is by knowing the type of the problem, the traits or characteristics that usually arise and indicates that something is included in problem factor.

To clarify the influential factors in the green industry, a series of measures were undertaken, i.e. First, conducting the collection of the government and international regulations, articles, e-books, and journals. These articles are collected from Google Scholar (GS) Database, Proquest, YouTube, Pdfdrive, Libgen, Google PlayBook, and a web that contains a collection of journals. Second, reviews some literature study on regulations, textbooks, e-books and articles on the green industry. Third, searching on various webs that were generating many articles in which discussing variables in the green industry, then these articles were grouped, checked, and selected that appropriate to the purposes of this study. Furthermore, the selected articles will be recorded as data and information to be presented and discussed. Fourth, discussion and resume the articles will be presented in table and presentation format.

3. Literature review
The green industry awareness lies in two pillars, namely continuous improvement and sustainable development, which includes two managerial aspects: total quality management and triple bottom line. The Triple Bottom Line (3BL) consists of three indicators namely, economic, environmental and social. 3BL is considered as one of the best ways to measure the company's performance. The industrial management systems can enhance the company's 3BL performance, which is Green, Lean, and Sustainable Systems [15].

The focus of green manufacturing focus is to minimize the impact of the manufacturing process and products, and is crucial for future sustainability, and gradually implement a lean manufacturing system. Lean is a catalyst for the implementation of the green manufacturing system [16]. Green and sustainable management systems have a positive impact on the company's performance in various aspects. Lean production systems have also been widely accepted in manufacturing and provided many benefits through the application of lean systems. Green, Lean and Sustainable Industrial Practices can be integrated. The resulting integration is referred to as GLS practice (Green, Lean, and Sustainable) [17].

Green Manufacturing is a method of manufacturing processes that minimize waste and pollution [18], in other words, defined as "Elimination of environmental waste and reduction of energy
consumption by redefining process or production system. " Green Manufacturing is a term used to describe the Sustainable Manufacturing, is a term that used to describe the environmentally friendly manufacturing practices throughout the manufacturing process, encourage the use of non-destructive processes [19]. Green Manufacturing is a method of manufacturing processes that minimize waste, in other words, defined as "Elimination of environmental waste and reduction of energy consumption by redefining processes or existing production systems [20]. Green Manufacturing is a method of manufacturing processes that suppress waste and pollution, focusing on minimizing the impact of manufacturing processes and products, and also crucial for future sustainability.

Lean Manufacturing is a system that aims to eliminate waste from the system with a systematic and sustainable approach [18]. In other words, lean production is a reduction in wasted material and labor [16]. Lean Production is a toolbox that aims to eliminate waste in the production process through continuous improvement. Green Manufacturing’s focus is to minimize the impact of the manufacturing process and products, and is crucial for future sustainability, and gradually implement a lean manufacturing system. Green and sustainable management system manufacturing is associated with the development that guarantees environmental protection, economic wealth and social justice, which is known as the three pillars of sustainable development. Sustainability aims to overcome the epidemic problems, such as environmental waste, economic inefficiencies, potential health and safety threats for humans and living beings that can occur as a function of product and service system activities [9].

NACFAM-USA (The National Council for Advanced Manufacturing – USA), defines sustainable manufacturing as "the creation of pollution-free manufacturing products, energy-saving, and natural resources products, economically and safely for workers, communities, and customers” [17]. The Ministry of Industry of Republic Indonesia has drafted the green industry concept in the Law of The Republic of Indonesia No. 3 the year 2014 on Industry that aims to regulate the manufacturing system in Indonesia. Also, the existence regulation No. 05/M-IND/PER/1/2011 stated that the green industry is defined as an environmentally friendly industry that aligns growth with environmental sustainability, prioritizing the efficiency and effectiveness of natural resource use and beneficial to the community.

As a further action to the Industrial Law, the Ministry of Industry issued the green industry Standards (SIH) for 17 types of industries which compiled based on the Indonesian standard five-digit business classification, which describes the provisions on definitions, technical requirements containing criteria, limitations, verification, and management requirements for the industry with the aim of supporting the development of a competitive and sustainable industry. The 17 types of green industries include: Portland cement industry, ceramic tiles, pulp and paper, powdered milk, single macro primary nutrient fertilizer, rubber- fuming, rubber crumbs, dyeing and refinishing textiles, white crystalline sugar, layered safety glass, hardened safety glass, other items of glass, glass sheet, tanning, leather preservation, flat and long steel products.

Identification is an activity that seeks, discovers, collects, examines, records data and information of a matter or a need. The aim is to find out a wide range of information from various sources that can be utilized to support and facilitate a thing that is being implemented. Identifying the influential factors is crucial in a series of industrial processes to achieve goals in the green industry. The importance of the factors affecting the variables in the green industry is analyzed to facilitate the implementation of the green industry concept in the industrial world.

4. Results and discussion

4.1. Factors of the green industry variables

Factors affecting the green industry are variables that have measurable values, and the results are influenced by the variables that affect it. The studies discussing the green industry, and the influencing factors are shown in table 1, as follows:
| References          | Title                                                                 | Identified Factors                                      |
|---------------------|----------------------------------------------------------------------|--------------------------------------------------------|
| [2] Tasdemir and Gazo. (2018) | A Systematic Literature Review for Better Understanding of Lean Driven Sustainability Green Industrial System in Indonesia | - Waste and energy                                     |
| [11] Amaranti, et al. (2017) | Green manufacturing, Literature Review                              | - Energy, technology and waste                         |
| [15] Lin hu, et al. (2015) | The impact of Integrated Practices of Lean, Green, And Social Management Systems on Firm Sustainability Performance – Evidence from Chinese Fashion Auto-Parts Suppliers | - Energy, material, waste, emissions, time, commitment and price/cost |
| [16] Bergmiller, et al. (2009) | Lean Manufacture’s Transcendence to GM                              | - Waste, management, and green result                  |
| [17] Tantayanubutz, et al. (2017) | Impact of Green Innovation on The Sustainable Performance of Thai Food Industry | - GSM, CSR, green innovation, cost and technology      |
| [18] Malhotra and Kumar (2017) | The Techniques of Lean and Green Manufacturing Systems              | - Quality, cost, time and waste                        |
| [19] Pathak and Singh (2017) | Sustainable Manufacturing Concepts: A Literature Review              | - Year of publication, country and methodology        |
| [21] Estiasih, et al. (2017) | Lean and Green Manufacturing Design at SMES’s Madura Shipyard with Value Stream Mapping Tool and Simulation Model | - Waste, time, performance, delivery, purchase and quality |
| [22] Negulescu (2015) | Sustainable Development: The Green Industry Contribution to Improving Global Business Environment | - Energy, waste, technology, production process and pollution |
| [23] Sopingi, et al. (2015) | The implementation of Green Industry in Small Industries of Tiles and Brick in Nganjuk District, East Java, Indonesia | - Energy, water, soil, time and quantity               |
| [24] Nurwahidah and Anityasari (2015) | Evaluation of The Implementation of Green Industry Program at PT. X, A Cement Industry in East Indonesia | - Energy, management, waste, emissions, material     |
| [25] Swapnil, et al (2015) | Implementation of Green Manufacturing in Industry – A Case Study    | - Emissions, waste, energy, technology                |
| [26] Qureshi, et al. (2015) | Sustainability: A New Manufacturing Paradigm                        | - Waste, quality, energy, cost Profit, emissions      |
| [27] Hanafi (2015) | Towards Sustainable Manufacturing in Indonesia: Challenges and Opportunities | - Material, energy, water, technology, emissions, and management |
| [28] Rinawati, et al. (2013) | Production Management Using Lean and Green Approach to Sustainable Batik Industry | - Waste, material, energy, additives                  |
Based on Table 1 above, factors affecting Green Industry are waste, energy, cost, technology, emissions, time, water, material, production, management, commitment, etc. Table 2 summarizes the identified factors, as follows:

| Rank | Factors    | Rank | Factors                                      |
|------|------------|------|----------------------------------------------|
| 1    | Waste      | 8    | Water                                        |
| 2    | Energy     | 9    | Quality                                      |
| 3    | Technology | 10   | Production Process                           |
| 4    | Emissions  | 11   | Management                                   |
| 5    | Cost       | 12   | Purchase                                     |
| 6    | Time       | 13   | Pollution                                    |
| 7    | Material   | 14   | Other Factors                                |

As previously mentioned, the green industry process is influenced by numerous factors and variables. One way to improve towards the green industry by implementing Lean Industry concepts. Also, by finding the best combination of sustainable industry concepts.

4.2. Methods on the green industry.

Problem-solving in the green industry process by using several methods that affecting the process towards the green industry is presented in Table 3.

Table 3. The applied methods on the green industry.

| References        | Title                                                                 | Approaches                                              |
|-------------------|-----------------------------------------------------------------------|---------------------------------------------------------|
| [2] Tasdemir and  | A Systematic Literature Review for Better Understanding of             | - Supply chain                                          |
| Gazo. (2018)      | Lean Driven Sustainability                                            | - Triple bottom line (3BL)                              |
|                   |                                                                       | - Six sigma                                             |
|                   |                                                                       | - VSM (Value Stream Mapping)                            |
|                   |                                                                       | - LCA (Life Cycle Assessment)                           |
| [5] Handoko, et al.| Green Industrial System in Indonesia                                 | - Cause and effect /fishbone diagram approach           |
| (2017)            |                                                                       | - Quality Function Deployment                           |
|                   |                                                                       | - Questionnaires                                        |
|                   |                                                                       | - Reliability and validity test                         |
|                   |                                                                       | - Techniques of Lean Manufacturing                      |
|                   |                                                                       | - Kan-ban system or pull- systems                       |
|                   |                                                                       | - SMED (single minute exchange of dies)                 |
|                   |                                                                       | - 5S (Sort, Set in Order, Shine, Standardize, Sustain)  |
|                   |                                                                       | - Techniques of Green                                   |
| Reference | Title                                                                 | Methodology                                                                                       |
|-----------|----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| [11] Amaranti, et al. (2017) | Green manufacturing, Literature Review | Manufacturing:  
- Changes in production processes  
- Changes in inputs in the production process  
- Internal re-use  
- Better housekeeping  
- A Literature review conducted by collecting articles using Google Scholar (GS) databases, Emerald, Science Direct, IECE, and Springer. |
| [19] Pathak and Singh (2017) | Sustainable Manufacturing Concepts: A Literature Review | - Questionnaires  
- Literature review  
- Survey  
- LCA (Life Cycle Assessment)  
- Product quantity analysis, and product route analysis  
- Value Stream Mapping (VSM) – Current State  
- Questionnaires and interview  
- Key Performance Indicator (KPI)  
- Value Stream Analysis Tool (VALSAT)  
- Fishbone  
- Failure Mode and Effect Analysis (FMEA)  
- Value Stream mapping (VSM) – Future State |
| [21] Estiasih, et al. (2017) | Lean and Green Manufacturing Design at SMES’s Madura Shipyard with Value Stream Mapping Tool and Simulation Model | - Literature’s investigation  
- Research result collection  
- Synthesis & Personal deduction and conceptualization  
- The Key Performance Indicator integrated with ISO, PROPER, Cement Industry Ability Initiatives/CSI, Green Cement uses an integrated environment.  
- Performance measurement  
- System/IEPMS approach.  
- Weighting KPIs (using AHP and interviews), KPI-weighted results using Expert Choice Software.  
- Assessment evaluation |
| [22] Negulescu (2015) | Sustainable Development: The Green Industry Contribution to Improving Global Business Environment | - Literature’s investigation  
- Research result collection  
- Synthesis & Personal deduction and conceptualization  
- The Key Performance Indicator integrated with ISO, PROPER, Cement Industry Ability Initiatives/CSI, Green Cement uses an integrated environment.  
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| [25] Swapnil, et al (2015) | Implementation of Green Manufacturing in Industry – A Case Study | - Literature’s investigation  
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- Weighting KPIs (using AHP and interviews), KPI-weighted results using Expert Choice Software.  
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| [23] Sopingi, et al. (2015) | The implementation of Green Industry in Small Industries of Tiles and Brick in Nganjuk | - Literature’s investigation  
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- Performance measurement  
- System/IEPMS approach.  
- Weighting KPIs (using AHP and interviews), KPI-weighted results using Expert Choice Software.  
- Assessment evaluation |
Some methods in Lean Industry as shown in Table 3, can be used to solve several problems in the green industry, especially related to the process of waste management on the production process. Based on Table 2, there are several methods that can be used to apply the concept of the green industry, such as: questionnaires (seven journals), Life Cycle Assessment/LCA (five journals), Value Stream Mapping/VSM (four journals), Key Performance Indicator/KPI (three journals), 3R and 4R (three journals), and Fish Bone Diagram (two journals).
Table 4. Method recapitulation in the green industry.

| Rank | Methods                                      |
|------|----------------------------------------------|
| 1    | Questionnaires                               |
| 2    | Life Cycle Assessment/ LCA                   |
| 3    | Value Stream Mapping/ VSM                    |
| 4    | Key Performance Indicator / KPI              |
| 5    | 3R and 4R                                    |
| 6    | Fish Bone Diagram                            |

5. Conclusion
The main objective of this paper is expected to provide an understanding of the improvement process towards to the green industry. As previously described, this paper is expected to describe the factors affecting the implementation of the green industry concept, from several journals and articles described above, it is found that the most influential factors in the green industry is waste which includes fourteen articles, energy consumption (thirteen articles), cost (eight articles), technology (seven articles), emissions (seven articles), time (five articles), raw materials (five articles), water usage (four articles), and quality (four articles). Also, management and commitment aspects as well as price also influential.

In Green Concept, infrastructure, designs, and systems are made as close as possible to the characteristics of the ecosystem, where energy utilization efficiently, materials or tools or raw materials are used from one entity to another in a renewable input system, while at the same time improving public welfare. The principles developed in the application of the green industry concept are:
- Energy efficiency and renewable energy usage.
- The efficiency of resource utilization.
- Linkages to the natural systems – humans.
- Green industrial park (Residential and green industrial complexes).
- Reduction and elimination of pollution, reductions of greenhouse gas effects, and/or the implementation of recycling.
- Conservation of natural resources.
- Compliance, training, and awareness of the environment.

Operationally, some industry can implement the green industry concept that includes, i.e.
- Prioritize the use of renewable resources.
- Using a series of efficient and effective production processes.
- Participating in efforts to maintain environmental functions.

With this operational definition, the efforts towards to the green industry must start from product design, material, energy usage, machine selection, process design (location and layout), production process, product handling (main, side, garbage), and product distribution/logistics. The problem solving with the genetic algorithm uses several variables affecting the order retrieval process i.e. travel time, pick a time, search time, setup time and worker efficiency. The expected results of applying this method are to improve warehouse efficiency by finding the best combination of each product storage location so that it can be minimized retrieval time, and maximize the work efficiency.
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