

# Overview of Lean-Green Approach

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## Abstract

Lean manufacturing is a method of optimizing industrial performance that allows companies to eliminate waste in processes and contributes to the reduction of environmental impact. The green manufacturing concept aims to preserve the environment (reduce pollution and waste), in addition to implementing environmentally friendly processes in manufacturing. This article talks about the lean-green combination, presenting its advantages such as: reducing waste, cost, meeting customer needs and improving productivity, and their implementation, two types of implementation have been found: sequentially or simultaneously. Moreover, this article paves the way for further research and the adoption of lean-green in the industry.

## Keywords

Green manufacturing, Lean manufacturing, Lean-green, Implementation, waste.

## 1. Introduction

Only a handful of environmental experts and researchers have so far investigated the relationship between aspects of lean and green practices, they found that lean companies which include green practices achieve better lean results than those companies which do not (Dües et al. 2013). So why lean green? Lean & green are complementary; therefore, each method has the potential to minimize the disadvantages of the others. Together, lean & green have the ability to identify waste and evaluate its environmental impact (Banawi and Bilec 2014).

The corporate environmentalism or green management emerged in 1990s and became popular slogan internationally in 2000s (Lee 2009). Green management is the organization-wide process of applying innovation to achieve sustainability, waste reduction, social responsibility, and a competitive advantage via continuous learning and development and by embracing environmental goals and strategies that are fully integrated with the goals and strategies of the organization (Haden et al. 2009). It is a management concept, which demands the commitment of all members of the corporation, from senior management down to the shop floor, GM is more than just corporate concern about the environment, it is a 'mind think' (Taylor 1992).

The term lean production is associated with the Toyota Production System where it is integrated with just-in-time tactics in order to improve quality and delivery time (Hajmohammad et al. 2013). Lean management is the reduction of variability at every opportunity, including demand variability, manufacturing variability, and supplier variability (Arnheiter and Maleyeff 2005), lean can enhance the benefits of pollution prevention approaches (Hallam and Contreras 2016).

Lean management and green management are two approaches to operations that companies have adopted, promoted and implemented in order to create better value through quality, products and services while trying to reduce manufacturing and/or environmental wastes (Hallam and Contreras 2016).

This article examine the different papers on lean-green approach; its definition, objectives and benefits to encourage companies to improve productivity, save costs and reduce waste and environmental impacts.

## 2. Lean Manufacturing: Definition and Principles

The word "Lean" was used by John Krafcik, to describe the new production techniques introduced by Taiichi Ohno at Toyota (Bendell 2006), it is not confined to the activities that take place in the manufacturing function of a company, rather it relates to activities ranging from product development, procurement and manufacturing over to distribution (Karlsson and Åhlström 1996). It is a set of practices aimed at reducing waste and non-value-added activities in the production (Lasnier 2007) (Yang et al. 2011). In addition, it is unique as it focuses on enabling

people to see the product or service and the whole value stream from the perspective of the customer. (Salah et al. 2010).

Lean has been used in manufacturing for decades and has been associated with enhanced product quality and overall corporate success. (Dickson et al. 2009). Thus lean manufacturing is considered as “best practice” and the most influential new paradigm for manufacturing in developed industries of the world (Forrester et al. 2010)

The Five key principles of LM as described by Womack and Jones (1996) are (Bendell 2006) :

- (1) The elimination of waste (or Muda);
- (2) The identification of the value stream;
- (3) The achievement of flow through the process;
- (4) Pacing by a pull (or Kanban) signal;
- (5) The continuous pursuit of perfection.

In lean concept, there are three types of waste from Japanese words: Mura, Muri, and Muda : Muri (overburden), Mura (unevenness) and Muda (Activities that do, not add any customer value), Muda is typified by its seven wastes(Noya and Chandra 2014). The seven wastes as follows, overproduction, inventory, extra processing steps, motion, defects, waiting, and transportation, (Noya and Chandra 2014). Some researches add other wastes such as, waste of human factor (eight)(Suárez-Barraza et al. 2016), and informational waste and membership waste (Elrhanimi et al. 2019).

### **3. Green Manufacturing: Definition and Principles**

The term "Green" is a verb which then refers to the process of reducing the environmental impact of a manufacturing process or system(Johansson and Sundin 2014). However, there are good "Green" practices, which are defined as a set of techniques that limit or reduce the potential negative impacts of the production and consumption of products and services on the natural environment, thus improving the ecological footprint of a company (Duarte and Cruz-Machado 2015).

Green manufacturing is a concept that addresses the negative environmental impacts caused by manufacturing activities(Johansson and Winroth 2009), in this respect organizations need to re-evaluate their products and processes while implementing environmentally responsible management practices (Hallam and Contreras 2016).

Green manufacturing focuses on integrating environmental improvements into industrial processes and products; reducing or preventing air, water and soil pollution; reducing waste at source; and minimizing risks to humans and other species are key issues (Johansson and Winroth 2009).

For this reason, researchers and managers are debating the value of investing in green manufacturing, as making the same product using fewer resources and/or energy is a good strategy for making money (Verrier et al. 2016). Thus, management should recognize that the cost of green manufacturing initiatives will be paid for by the money saved in a more efficient system which, in turn, will have a positive impact on the return on investment (ROI) (Verrier et al. 2016).

### **4. Lean & Green Compatibility**

Lack of understanding the relationship between the concepts of "Lean" & "Green" manufacturing is a problem (Johansson and Winroth 2009); To understand this relationship we found that the "Lean" & "Green" research areas have developed relatively independently of each other, but few have studied and analyzed the relationship or interaction between these two concepts (Johansson and Sundin 2014). Some researchers claim that "Lean" & "Green" approaches are synergistic (Duarte and Cruz-Machado 2015). For instance Dües et al. (2013) identify that lean not only serves as a catalyst but is also synergistic for green, and that green in turn also has positive influence in lean. This prove positive links between lean and green paradigms (Verrier et al. 2016). To sum up the lean & green paradigm is constituted in the following common attributes: waste and waste reduction techniques, lead time reduction, supply chain relationship, and also certain common tools (Dües et al. 2013).

"Lean" and "Green" are often seen as compatible initiatives because of their joint focus on waste reduction, resource efficiency and meeting customer needs (Duarte and Cruz-Machado 2013). The lean & green manufacturing concepts shows that they are complementary and to some degree overlapping, both concepts

promote resource productivity in the manufacturing industry (Johansson and Winroth 2009b). The strongest positive evidence between the two management philosophies has been for lean implementation pushing green outcomes through operational waste reduction, thus improving environmental performance (Hallam and Contreras 2016).

The philosophies of lean-green management can also be at odds with each other (Hallam and Contreras 2016). Other authors note that lean-green practices may not have a positive effect on operational and environmental performance. Similarly, there is some evidence that environmental practices have negative effects on operational performance (Galeazzo et al. 2014). However, lean strategies that employ just-in-time (JIT) delivery of small lot sizes can require increased transportation, packaging, and handling that may contradict a green approach. This example, while simplistic, is meant to illustrate the potential for synergies and conflicts that may arise when implementing any combination of lean & green (Mollenkopf and al. 2010). Despite the importance of the synergistic relationship between lean and green practices, there are areas where the two paradigms cannot be combined. For instance reduces air pollutant emissions, but does stand in conflict with JIT principles (Dües et al. 2013). Using lean practices which aim at eliminating any rework and working under the 'get it right the first time' principle, manufacturers use spray paints which yield better quality and additionally are more cost effective. On the contrary, spray paints mean greater harm for the environment. (Dües et al. 2013).

## **5. Lean-Green**

### **5.1 Lean-Green: Definition**

Lean-Green (L&G) is an approach that can provide an ideal framework for delivering cleaner, more valuable products with the right processes (Abreu et al. 2017). This approach aims to develop an improvement plan to reduce waste treatment costs, and at the same time improve environmental and social impacts (Fercoq et al. 2013). Furthermore the L&G approach complements and enhances the efficiency and effectiveness of the results of operations compared to the individual approach (Leong et al. 2019).

### **5.2 Lean & Green Advantage**

The quantitative benefits of integrating lean and green production are reduced production lead times, improved value-added time (Thanki et al. 2016). In addition, reduce waste, use resources efficiently and satisfy customer needs at the lowest possible cost (Duarte and Cruz-Machado 2013). Thus the lean & green paradigms make almost equal in improving the organization's overall performance (Thanki et al. 2016).

Both "Green" & "Lean" approaches have been adopted by manufacturing companies around the world, as the simultaneous deployment of green and lean practices can improve business performance while creating economic, social and environmental benefits (Azevedo et al. 2012). Despite the fact that the lean management paradigm improves quality and productivity and reduces waste in all operations (Duarte and Cruz-Machado 2013), but this shows that lean production activities are not necessarily and by definition optimal from an environmental point of view (Herrmann et al. 2008). the fact that the environmental constraint will change the face of the industry (MkA 2019), lean companies are starting to involve the integration of the green environmental perspective (Herrmann et al. 2008), as a result, companies that adopt green practices perform better than those that do not (Hartini and Ciptomulyono 2015). Lean & green thinking focuses on improving business performance in terms of cost, market position, reputation and product design (Wiese et al. 2015). Green management programs can maximize their gains when lean methods are applied to specific pollution prevention activities(Hallam and Contreras 2016).

Integration of different management systems is beneficial(Kurdve et al. 2014). Companies have developed their XPSs, company-specific lean-based improvement programs, in the form of production systems, governed by XPS-specific principles, XPS principles largely resemble the principles of the lean production, we can say that lean production principles actually form the basis of the majority of the XPS (Netland 2013). Kurdve et al show the mutual benefit and the need to further combine XPS\Lean production with especially EMS (Environmental Management Systems) and the advantage of working towards integration (Kurdve et al. 2014). The green-lean infrastructure system provides a channel for the successful implementation of green best practices and the achievement of corresponding green results. Lean & green concepts require attitudinal change and the development of organizational cultures that support the philosophy behind each concept (Duarte and Cruz-Machado 2013), in addition The quantitative benefits of "Lean" & "Green" integration are reduced production lead times, improved value-added time, reduced carbon footprint, i.e. reduced greenhouse gas emissions and improved overall equipment efficiency (OEE)(Thanki et al. 2016).

Manufacturers can simultaneously adopt and combine lean & green strategies in order to create an environmental stance that is a driver for reduced costs and risks, increased revenue, and improved brand (Fercoq et al. 2016). Azevedo et al. (2012) presents a survey on the relationship between lean and green practices upstream of a SCM

(Supply Chain Management) and the economic, social and environmental performance of a company at a Portuguese car manufacturer. Below are the results of the case study:

- ✓ The lean & green upstream SCM practices contribute to improve economic, social, and environmental performance.
- ✓ The deployment of lean & green upstream SCM practices influences the sustainable development of businesses in an SC context.

Overall, the benefits of lean-green coordination can be summed up as follows: (US EPA 2013)

- ✓ Cost reduction
- ✓ Improvement of process flow and reduction of lead times
- ✓ Reduced risk of non-compliance with regulations
- ✓ Meeting customer expectations
- ✓ Improvement of the quality of the environment
- ✓ Improving employee morale and engagement

### **5.3 Wasted of Lean-Green**

Using the professional experiences of the work team (they have between 4 and 10 years of experience especially in the automotive field), the team identified eight types wasted of lean-green : Excessive use of the water, Excessive Consumption of energy, Excessive use of the resource, Pollution, Garbage, Greenhouse effect, Eutrophication and Poor health and safety (Elrhanimi et al. 2019).

## **6. Implementation of Lean-Green**

Implementing the integrated lean-green approach improves environmental performance and brings benefits to the business (Szymańska-Brałkowska and Malinowska 2018). A case study clearly shows that there is enormous potential for the implementation of lean-green approach in small industries to conserve resources and the planet (Nallusamy et al. 2015).

The effective implementation of manufacturing strategies such as "Lean-Green" depends on various factors such as integration between different departments, an organizational culture, employee training and development, and customer involvement(Singh et al. 2007). Indeed to have a good implementation within an organization the commitment of top-down management is the key to the implementation of LG manufacturing (Leong et al. 2019) as well as the involvement of employees to succeed (Duarte and Cruz-Machado 2013). The human factor is the key issue in the lean-green approach and employees should be motivated to understand the economic and environmental aspects of change. (Szymańska-Brałkowska and Malinowska 2018).

### **6.1 Type of Lean-Green Implementation**

Some authors suggest that lean-green practices throughout the supply chain stimulate the company's financial performance and gain the respect of customers, so it is important to integrate and implement them simultaneously to take advantage of their synergies (Mollenkopf and al. 2010). Then Bergmiller and McCright (2009) assert that companies pursuing lean objectives will be more successful if they also pursue green objectives, and vice versa, i.e. the parallel implementation of lean-green paradigm brings significant benefits and success to the company. Galeazzo et al. (2014) suggest that "Lean" & "Green" practices can be introduced either sequentially or simultaneously where managers generate sequential or simultaneous interdependencies.

### **6.2 Models for Lean-Green Implementation**

The lean-green model demonstrates a new and innovative approach to support the development of sustainable businesses (Pampanelli et al. 2014). The model mentioned integrate environmental sustainability into pure lean thinking (Pampanelli et al. 2014). Many researchers have identified several models, of which five have been identified. These models are: Theoretical framework, Pull methodology and model, lean-green model, Integrated System of Management (ISMA) and lean-green House and maturity model (theoretical) (Abreu et al. 2017). The five models presented are linked to the lean-green (LG) models. Only two models are coined lean-green, namely Lean-green model and maturity model (Abreu et al. 2017). The introduction of cost-effective lean-green models for the manufacturing industry and educating employers about long-term environmental benefits would be highly desirable (Chiet and al. 2019). In addition Pampanelli et al. (2014) propose a model that integrates lean-green approach for application at the manufacturing cell level.

The model consists of the following five steps :(Ng et al. 2015)

- Step 1: Stabilize the value stream (VS)
- Step 2: Identify environmental aspects and impacts
- Step 3: Measuring Environmental Value Steams
- Step 4: Improve environmental value Steams
- Step 5: Continuous Improvement

In conclusion, the models aim to develop an improvement plan to reduce waste treatment costs, and at the same time improve environmental and social impacts (Fercoq et al. 2013).

### 6.3 Barriers in Lean-Green implementation

However, there are barriers to the implementation of the LG, which have been identified by the ISM method [Interpretive Structural Modelling Methodology (ISM), it was used to understand the relationship between the 15 barriers and to develop a hierarchical model of them], among the 15 barriers: Lack of environmental awareness; Fear of failure; Lack of expertise; Poor quality of human resources; Lack of government support to integrate green practices; Lack of top management involvement in adopting green lean initiative; Poor corporate culture that separates environmental and continuous improvement decisions(Cherrafi et al. 2017) (Thanki and Thakkar 2018).

According to a case study of a company, that has implemented the lean-green approach (Lean and Green); it has therefore also discovered problems during implementation. Though the years those problems were: (Szymańska-Brałkowska and Malinowska 2018)

- ✓ The lack of authority to implement changes;
- ✓ The lack of support from supervisors;
- ✓ The lack of proper involvement and engagement of the employees;
- ✓ Problems with employees' motivation;
- ✓ Low knowledge level of the employees about the environmental issues.

Lack of environmental awareness' and 'lack of government support to integrate green practices' were determined to be key barriers in lean-green implementation (Cherrafi et al. 2017), that is why Government support" has been identified as the most important in the implementation of the "lean-green" approach in the case of Indian SMEs (Thanki and Thakkar 2018).

Cherrafi et al. (2017) suggest that some of the crucial barriers that hinder lean-green implementation are related to the human category. Therefore, these barriers should be identified and eliminated for the most effective LG (Kumar et al. 2016).

## 7. Conclusion

The compatibility between lean and green approaches lies in their synergy, their positive link and the common goal found in their advantages. Lean-green is a good approach for the company to provide good quality products with good processes while preserving the environment. The benefits of lean-green include reducing costs and waste, satisfying customer needs, improving productivity, and enhancing the company's performance in terms of market position, product design and reputation. The implementation of the lean-green approach brings lasting benefits to the company. Successful implementation of this approach depends on several key factors such as communication between the different departments, training, employee development, and commitment from top management. In general, the human factor is the key to a good implementation of lean-green. Some researchers suggest implementing them simultaneously/parallel, while others suggest that they can be implemented sequentially or simultaneously. On the other hand, there are barriers to the implementation of LG such as poor quality of human resources, lack of involvement of senior management and lack of environmental awareness.

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