

## Alliance of Lean and Green in Company: a Literature Review and Future Research

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**Abstract:** The objective of this paper is to scout about and evaluate previous work focusing on the relationship and links between Lean and Green in company practices. Many explanatory frameworks are explored and discussed. Our goal in this paper is to develop our understanding of where Lean practices are synergistic for Green, to clarify if Green practices are synergistic for Lean and to identify occasions for companies to use their Lean framework as a tool to making their practices Green. This paper shows evidence suggesting that Lean has a positive impact on Green practices and the implementation of Green practices in turn also has a positive impact on existing Lean company's practices.

**Keywords:** Company, Lean, Green, Environment, Management

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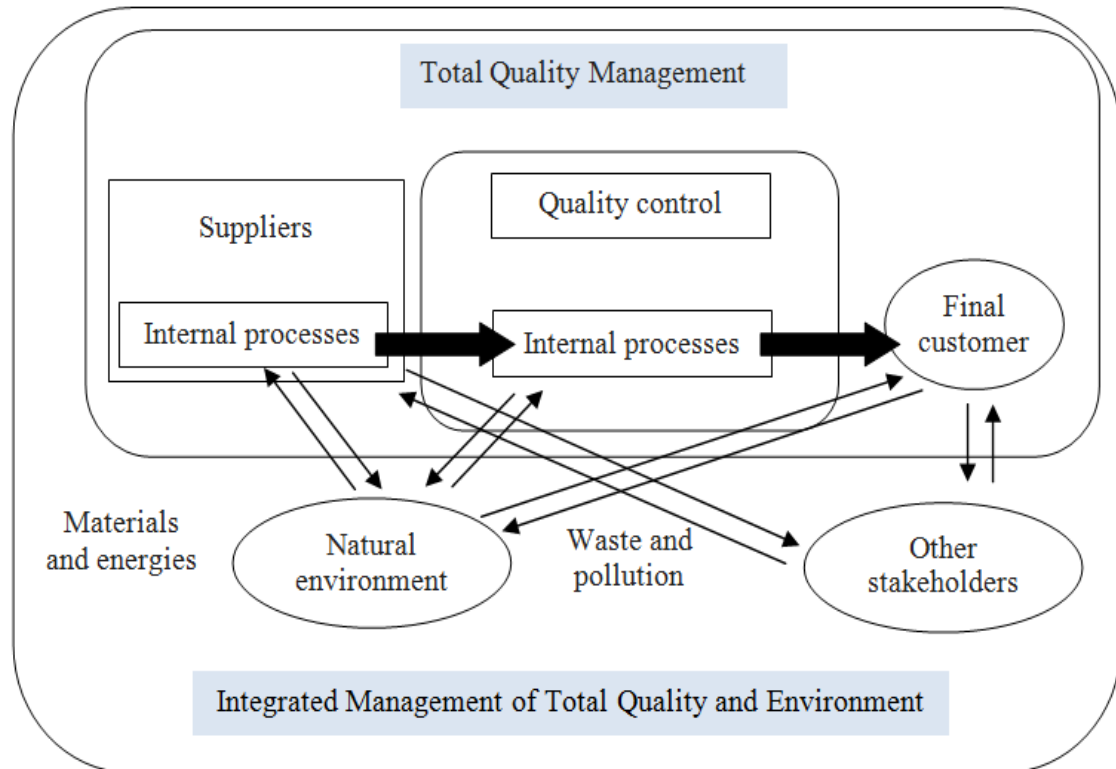
### I. Introduction

In the context where customer has become more demanding, adoption of Lean Management has become widespread in companies of developed countries. It aims to accelerate flows and reduce non-value added in framework of continuous improvement process. Improving quality and productivity reduces the cost of products and services. More recently, there has been increasing interest in environmental and social concerns. Since the end of the eighties, sustainable development concept has been taken into account in companies thinking. A sustainable company is one which contributes to development by simultaneously providing economic, environmental and social benefits. Corporate Social Responsibility (CSR) is the contribution of companies to sustainable development issues.

Lean aims to eliminate wastes in the process which reduces efficiency and performance of company, it reduces waste production, thus creating a beneficial effect for environment. Companies must adopt a balanced strategy where Lean integrates environmentally friendly practices. Waste control and disposal is one of the five principles of Lean Management, which is focused on reducing any type of waste. While Lean practitioners have traditionally focused on what they call the seven forms of waste, environmental wastes are seen as an additional waste without value (which is done but does not add value to the product or service).

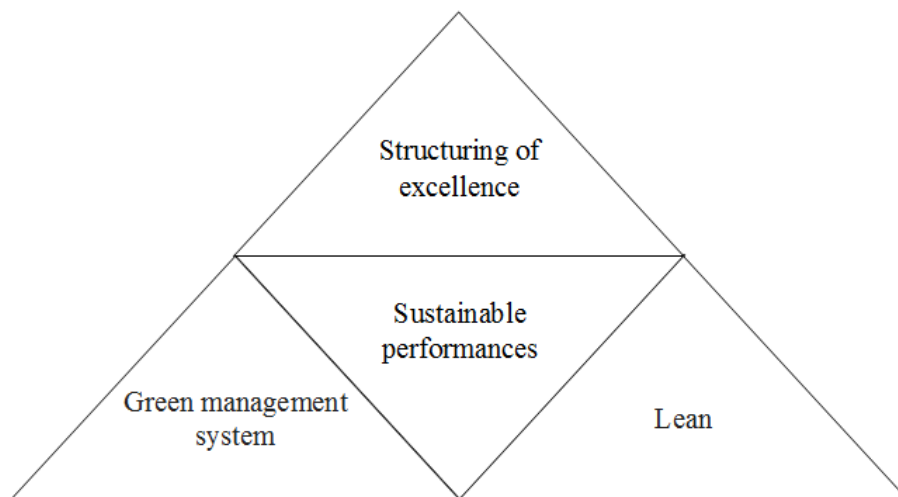
### II. Strategic Ways Explored on Lean Green Integration

As early as 1996, Florida was the source of a study that made reference. He conducted a structured survey of 450 US plants. He said that 43% of the factories studied were based on a Total Quality Environmental Management (TQEM) program, which extended quality management principles to environmental aspects. More recently, (Corbett and Klassen, 2006) [1] worked on the evolution of Total Quality Management, to display the Integrated Management concept of Total Quality and Environment (Figure 1). A systemic and integrated approach, from a managerial point of view, is the right way to reconcile Lean and Green.



**Figure 1.** Integrated Management of Total Quality and Environment [1]

Pojasek (2008) [2] also offers an integrated strategy, the Lean Green Management System for sustainable performance. Three levers lead to a sustainable activity: Lean, Green Management System and a Structuring of Excellence, based on a network of indicators, guiding principles and some good practices (Figure 2). Environmental decisions are then part of overall management system of organization. Lean and Green approaches are aligned, for the conduct of continuous improvement programs.



**Figure 2.** Lean Green Management System for sustainable performance [2]

The next year, Bergmiller and McCright (2009) [3] present an integrated Lean Green model which links a management system, loss reduction techniques and performance results (Tab. 1). Results of their study indicate that Lean and Green programs are synergistic in terms of performance.

**Table 1.** Lean Green Model [3]

Lean / Green Management System	Lean Green Loss Reduction Techniques	Lean / Green Performance Results
<ul style="list-style-type: none"> <li>▪ Leadership</li> <li>▪ Empowerment</li> <li>▪ Management System Environmental</li> <li>▪ ISO 14001 certification</li> </ul>	<ul style="list-style-type: none"> <li>▪ Vision and Strategy -</li> <li>▪ Innovation-Partnerships -</li> <li>▪ Alliances -Operations</li> <li>▪ Support functions</li> <li>▪ Modification of product and process design</li> <li>▪ Dismantling – Substitution</li> <li>▪ Reduction - Recycling – Remanufacturing</li> <li>▪ Internal consumption</li> <li>▪ Extended use</li> <li>▪ Return packaging</li> <li>▪ Risk management</li> <li>▪ Creation of new markets</li> <li>▪ Wastes sorting</li> </ul>	<ul style="list-style-type: none"> <li>▪ Quality – Cost</li> <li>▪ Deliveries service rate</li> <li>▪ Customer satisfaction</li> <li>▪ Profitability</li> <li>▪ Delay</li> <li>▪ Position in relation to the market</li> <li>▪ Reputation</li> <li>▪ Product Design</li> <li>▪ Losses in process / equipment</li> <li>▪ Benefits</li> <li>▪ Sales</li> </ul>

More recently, Porter and Kramer (2011) [4] presented the concept of Shared Value Creation as a strategy which improves company competitiveness while simultaneously advancing economic and social conditions of communities in which it operates. Firms can create economic value through the creation of societal value. Authors suggests three different ways of doing this: changing product and market conception, productivity in value chain (in terms of energy and resource use across supply chain) and construction of industrial clusters around the company.

Finally, integrated concept "LARG" (Lean, Agile, Resilient, Green) was studied [5]. The four paradigms have the same overall objective: satisfy the customer’s needs at the best possible cost for all supply chain actors. Each concept, however, has these specificities: Lean aims at minimizing the non-added values; Agility focuses on a rapid response to market evolutions; Resilience seeks to respond effectively to disruptions and Green management minimizes environmental impacts.

### III. Political/Normative Dimension of Lean Green Integration

It is important to define the main drivers of a Lean Green policy. Mollenkopf et al. (2010) [6] provide interesting insights by distinguishing between internal factors (cost reduction, improved profitability, risks management of basic products and preservation of a corporate culture) and external factors (governments, clients and environmental pressures).

Specifically, standards and guidelines are frameworks in which companies can or should establish their policies, commitments and actions of progress. ISO standards define requirements or provide guidelines on the best management practices for company. ISO 9001 management system sets quality requirements and ISO 14001 management system mentions environmental requirements. Both systems are in fact highly convergent.

Toyota is an excellent example of a company which has successfully integrated a Lean Green strategy for its supply chain in a universal context, relying on international standards. Toyota's commitment has resulted in a systematic deployment of ISO 9000 and 14000 certifications for its sites. Other contributions have shown that organizations certified ISO 9000 naturally adopt ISO 14000 environmental standard. Indeed, the excellence of business processes is implicitly or explicitly a prerequisite for an effective Green strategy.

Recently, new specific areas have been covered by the production of international norms and standards. Thus, the ISO 50001 energy management standard was launched in 2011. In fact, it is estimated that the standard could have an impact on nearly 60% of the world's energy consumption. ISO 50001 would allow companies to increase their energy efficiency, reduce costs and improve energy performance. To date, no standard on the implementation of a waste management system is yet available.

### IV. Lean Green and Production Activity

It is in the field of production that the Lean concept has been initiated. The goal of Production Lean (Lean Manufacturing) is to accelerate flows by reducing non-value added as part of a continuous improvement process [7]. Green management in production focuses on resources efficiency (materials, energy) and wastes reduction. These actions constitute a major component of eco-efficiency concept [8]. Clean production aims to prevent pollution at its source.

Lean production systems are complementary to environmental practices and reduce the marginal cost of reducing pollution [9]. The increasing use of "Lean" and "Six Sigma" to master production processes presents an important opportunity to reduce negative environmental impacts through improved overall efficiency [10].

Industrial engineering aims to improve human activities, operations and technology and is based on the Lean concept. For its part, Green Engineering conducts some environmental actions: choosing materials with low environmental impact, defining cleaner production processes, maximizing energy and water efficacy, minimizing wastes and designing processes for recycling and for reuse of materials. These two engineering must work together to achieve optimal economic and environmental performances.

### **V. Impact of Lean Green on Company's Performances**

Lean production has an impact on performance perceived by customer (shorter lead times, lower prices and better quality) [11], as well as on financial performance by improving process efficiency. Lean's actions (loss minimization, flow acceleration...) are significantly correlated with operational performance (delivery time, unit cost of product, overall productivity, all customer satisfaction,...).

Beyond the impact on environmental performance, Green management alone does not necessarily improve company financial performance. Indeed, implementation of a green supply chain leads to high costs [12]. Many studies have, however, shown positive relationships between environmental efficacy and other performance indicators such as quality and cost [13]. Environmental Management improves operational performance (quality, cost, delay, flexibility, attractiveness of new products). An environmental management oriented "business" can even improve turnover.

About Lean Green integration, "environmental loss reduction techniques" which concretize this model lead a better operational and overall performances: costs, lead times, quality, customer satisfaction, profits [3]. Lean Green combination improves performances [14]. The results show that Lean's previous experiences have a positive impact on environmental practices. It is the environmental performance improvement as such that will positively impact the firm's results.

Still on Lean Green integration, a study of link between Green management and operational performance for supply chain in terms of time, service level and cost was done [15]. Table 2 shows the convergence points between Lean and Green managements on operational performances. A point of divergence focuses solely on a steering factor of stocks, the frequency of completely.

**Table 2.** Lean and Green Comparison [15]

	<b>Lean</b>	<b>Green</b>
Production time	Reduction	Reduction
Transport time	Reduction	Reduction
Stock level	Reduction	Reduction
Taux d'utilisation des ressources	Increase	Increase
Frequency of completely	High	Low

A survey of 75 companies in the automotive sector in Brazil showed that Management Lean and Human Resources Management were contributing levers to environmental management practices that positively impact operational performances.

In their recent state of art, Dües et al. (2013) [16] outline expected results and performance indicators associated to Lean and Green management (Table 3).

**Table 3.** Performance indicators associated to Lean and Green management [16]

	<b>Management Lean</b>	<b>Management Green</b>
Expected performance	Quality, Cost, Delay, Customer Satisfaction, Profitability	Quality, Cost, Delay, Customer Satisfaction, Market Position, Reputation, New Products, pollution
Performance indicators	Cost, Service rate	CO2, Service rate

### **VI. Lean Green and Continuous Improvement**

Lean management is a powerful demarche whose one of its foundations is the processes improvement. Continuous improvement, also called in Japan Kaizen, is of strategic importance but is difficult to implement. Key success factors for continuous improvement over the long term have been studied recently. It is essential to structure the process of continuous improvement: strong involvement of intermediary and proximity managers, objectives deployment, combined conduct of innovation projects and progress actions, provision of working methods and a strong mobilization of staff. Successful staff mobilization has a direct impact on outcome of a Lean transformation.

**I propose to add the example of 5S because it is an important tool of continuous improvement in Lean management aims to change behavior and mentality of operators and the coaching which can be allied also to environmental management.**

**The first letters of 5 Japanese terms (Seiri: sort, Seiton: tidy, Seiso: clean, Seiketsu: standardize, Shitsuke: respect) which aim to eliminate causes of many small problems, sources of loss of efficacy. This is one of the first methods to be implemented in a Lean Management demarche.**

It should be noted that environmental management contributes to process of continuous improvement and therefore to company's competitiveness. Companies that adopt a management system based on ISO 9001 and ISO 14001 are committed to adopt the continuous improvement. These management standards do not prescribe specific methods for generating improvement; so, Lean Management allows integration of best practices in order to perpetuate continuous progress, such as analysis of root causes to eliminate any type of losses.

From a methodological point of view, Toyota's 5R program (Reconceive, Reduce, Reuse, Recycle, Recover Energy) provides a framework to reduce any form of waste. Parker, (2008) [17] insist on the convergence of Lean and Green demarches, since they require similar methods, including audit and evaluation. To optimize the matter and energy flows, Pampanelli et al. (2014) [18] propose an integrated Lean Green process structured in five steps, close to DMAIC (Define / Measure / Analysis / Improve / Control), of 6 sigma approach. The first step is to define the value chain to be studied. Then the environmental impacts are identified. The third step measures the environmental value flows. A problem solving approach in team allow then to optimize these flows. Finally, the resulting action plan is regularly monitored and adjusted as part of a continuous improvement process.

In their state of art, Dües et al. (2013) [16], mention a Lean Green tool, "sustainable value flow mapping", an extension of traditional Value Stream Mapping (VSM) of Lean and point out that CO<sub>2</sub> emission is an additional source of loss.

## VII. Conclusion

This paper provides and identify potential areas in which companies can integrate Green into current business practices. To find the best Lean and Green alliance, it is necessary to understand different attributes of these two concepts. The research results show that a Lean environment serves as a catalyst to facilitate Green implementation. The integration of Lean and Green practices will bring many benefits to firms and introducing Green as the new Lean. It is sure that the ultimate Lean will be Green.

Lean and Green managements aim the process excellence. Concerning the integration of these two concepts, many researchers have worked on Lean Green in production since the end of the nineties to the present time; they emphasize the great convergence of concepts. So, future work on Lean Green integration can contribute to strategic innovations, growth-generating, job-creating and responding to fundamental societal developments.

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