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SUSTAINABLE OPERATIONS AND LEAN MANAGEMENT: TOWARDS AN INTEGRATED APPROACH

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Abstract

We examine the relationship between sustainable operations and lean management. Our intent is to understand how green and lean practices are intertwined and we approach such issue by using the qualitative method of case study and in-depth interviews, in order to investigate the process of realization of two projects in an Italian plant. Our results suggest that lean manufacturing may improve operational and environmental performance if it is implemented in association with sustainable practices, by demonstrating the existence of integration. Furthermore, we support prior literature on the positive impact of environmental management on firm performance.

Introduction

There has been a common interest over recent years on the investigation of environmental management in terms of its impact on firm performance (Kassinis and Vafeas 2009, Filbeck and Gorman 2004, Yu, Ting and Wu 2009). Contradictory results highlight that scholars have not found a clear interpretation of such relationship and that it is still premature to conclude that green pays (Walley and Whitehead 1994, Orsato 2006, Telle 2006).

A stream of research suggests to investigate how firm's specific features and strategies may act as enablers to better implementing green practices eventually achieving higher environmental and economic performance.

Sroufe (2003) demonstrates that the adoption of an Environmental Management System(EMS) allows for a positive integration among environmental practices and, indirectly, improves the firm performance. Pil and Rothenberg (2003) find that environmental practices have commonalities with the TQM, since it results in a mutual correlation with quality and an incremental benefit on firm performance.

Moreover, Christmann (2000) shows that innovative capabilities and early timing of environmental investments have a moderator effect on operational benefits, by making easier the implementation of environmental best practices.

In general, it is important to consider the circumstances under which environmental strategies

contribute to a firm's competitiveness (Reinhardt 1999).

This study follows this stream of literature and further develops those factors and strategies that affect environmental and operational performance, by reflecting on how specific type of practices are related to sustainable operations. Specifically, we rely on lean management and we contribute to expand the research on green and lean manufacturing.

In this paper, we examine lean management by investigating the links between green and lean practices, developing evidence of complementarity, substitution or opposition, and finally we gain an understanding of their impact on environmental and operational performance. Our research is based on the study of two projects implemented by the Italian plant of a multinational company with headquarters in Sweden. This case study highlights the positive relationship between lean initiatives and green performance, as well as between green initiatives and operational performance. Moreover, based on the case evidence we maintain that lean and green practices are to be implemented together if one is aimed at maximizing operational and environmental performance, by demonstrating the existence of a strategic integration.

In the following paragraph, we introduce a theoretical framework that represents the basis of our case study. The research methodology and a description of the data collection process is then described. Finally, we present the two projects and we conclude with a discussion of results and implications.

Literature Review

Green management is generally associated with pollution reduction but it has been proven that it may also provide cost savings, by increasing efficiency in production processes (Florida 1996;

Hart 1995; Porter and van der Linde 1995), and a better firm performance, by facilitating the creation of resources and capabilities as well as the ability to innovate (Porter and Van der Linde 1995, Russo and Fouts 1997, Reinhardt 1999). Anyway, scholars do not agree on the benefits of reducing pollution and they raise a problem of trade-off between environmental initiatives and economic performance, mainly caused by the cost of compliance with environmental goals (Clark et al. 1994, Walley and Whitehead 1994, Kassinis and Vafeas 2009, Filbeck and Gorman 2004, Yu, Ting and Wu 2009). In the following paragraphs, we present a brief description of sustainable practices and we report some examples of joint implementation of green and lean practices, providing a basis for the construction of our case study.

Green Management: Defining sustainable practices

As Hart (1995) suggests, firms that want to reduce their emissions can choose from a portfolio of pollution abatement equipments, referred to as pollution prevention, pollution control and product stewardship. Pollution prevention entails all the activities that affect structurally the production process with the aim of increasing resource efficiency or changing material use. Pollution control entails all the end-of-pipe equipments that serve to recognize, capture and dispose of emissions caused by the production process, without any intervention on pollution reduction. Product stewardship is related to the environmental impact of a product and it is generally associated with the redesign of the product and its development process. In their “environmental technology portfolio”, Klassen and Whybark (1999) introduce environmental management systems, along with investments in pollution prevention and pollution control technologies. In general, pollution prevention creates value, thanks to a more efficient use of resources, and it is associated with a better environmental performance, whereas pollution control is correlated with a lower environmental performance (Porter and van der Linde 1995,

Klassen and Whybark 1999). Yet, Christmann (2000) finds that pollution prevention technologies do not reduce manufacturing costs while Rusinko (2007) suggests a positive impact of pollution prevention on cost savings and competitive advantage.

Sustainable practices and the relationship with lean management

Literature focusing on the relationship between lean and environmental management suggests that there exists a positive impact of lean practices on the environmental position of a firm (Shrivastava 1995; Florida 1996; Hart 1997; King and Lenox 2001; Rothenberg et al. 2001). Indeed, lean philosophy fits perfectly with many environmental initiatives, by sharing common objectives such as productivity improvement, total quality, cost reduction, continuous improvement, and technological innovation (Florida 1996). King and Lenox (2001) demonstrate, through an analysis of 17,499 US manufacturing plants, that lean production is associated with a lower use of end-of-pipe treatment and a higher environmental performance. Also Rothenberg et al. (2001) highlight a positive relationship between waste prevention and lean manufacturing on the base of both quantitative and qualitative research. Similarly, Klassen (2000) argues that the implementation of both JIT and pollution prevention technologies seems to yield “overlapping benefits”, resulting in the improvement of environmental and firm performance.

On the other hand, not all the literature on lean management agrees on its positive implication for the environment. Zhu and Sarkis (2004) find that JIT is likely to decrease the positive relationship of green practices with environmental performance. A similar contribution, reported by Cusumano (1994) and Rothenberg et al. (2001), maintains that the higher frequency of JIT deliveries increases pollution.

To summarize, new opportunities for environmental strategies can be created by implementing

lean practices but it is still open the debate about the extent to which such advantages are dependent to lean practices and are affected by an integrated implementation with green practices.

Research Methodology

Case study is the first step of our research project aimed at shedding light on exploratory hypothesis. By comparing lean and green practices, this paper will help to understand how a firm can conjugate operation management with environmental sustainability and how the two domains can generate synergies and impact performance.

Our research is based on case studies of a Multinational company, Alfa Laval, which is highly involved in the implementation of lean and green practices.

Case study method involves an in-depth examination of a single instance (a case) and provides a systematic way of looking at events, collecting data, analyzing information, and reporting the results.

A case study approach was taken also for the reason that we intend to explore a relative new research area, in which theory is still emerging.

The case study approach is most likely to be appropriate for “how” and “why” questions in exploring the complementarity of lean and green, where theory is still emerging. Furthermore, case studies allow for a detailed investigation of the factors encountered in identifying and integrating new practices into the plant and provide a rich set of data, both qualitative and quantitative, for evaluating the results (Yin, 1994).

We developed a research protocol, following a theoretical framework, and it was used to structure our questions being addressed to General managers, Operation managers and

Environmental managers. The authors jointly conducted all the interviews.

Data were collected through on-site visits and extensive interviews of an average duration of three hours. The entire process required a total of a three-month period.

The research aims at investigating companies' concerns and awareness about operational and environmental issues, by means of a qualitative analysis on the impact of lean and green practices on the performance.

In particular, we intend to assess and test if there exists a relationship of complementarity, i.e. if the joint implementation of lean and green practices leads to higher performances. In other terms, we hypothesize that the operational, environmental and financial results stemming from the joint implementation of lean and green practices outperform the sum of the results of lean and green practices taken in isolation.

The research protocol questions include the following:

1. To what extent the lean and green practices have been adopted within the plant;
2. To what extent and why the green and lean practices overlap/create synergies;
3. How lean and green techniques affect:
 - 3.a Environmental performance
 - 3.b Operational performance
 - 3.c Financial performance

The two case studies, described in the next section, focused on understanding these issues.

Alfa Laval

Alfa Laval AB, a Swedish company founded in 1883, is a leading global provider of specialized products and solutions used to heat, cool, separate and transport products such as

oil, water, chemicals, beverages, foodstuffs, starch and pharmaceuticals. Alfa Laval's mission is to optimize the performance of its customer's processes.

The core of Alfa Laval's operations is based on three key technologies of great significance for industrial companies: heat transfer, separation, fluid handling.

In 2008, the company had a turnover of €2.719 million, with an increase of 11,5% over previous year.

It is a global company, with approximately 12.000 employees worldwide, customers in more than 100 countries and 27 large- and medium- size manufacturing units (15 in Europe, 7 in Asia, 4 in US and 1 in Brazil).

In particular, we have chosen to investigate the manufacturing plant in Alonte (Vicenza) because of its long experience in lean and green management. Indeed, the plant manager has always demonstrated a proactive attitude toward the adoption of strategies able to reduce waste, by implementing lean and green practices in advance with respect to many other Alfa Laval plants.

The company statement emphasizes the concept that everything they do has an impact on the environment and that the world is looking for ways to reduce pollution, supply clean water, consume less energy and find renewable sources of energy.

During 125 years, Alfa Laval has been providing customers with solutions that help them to re-use and protect natural resources such as energy and water in industrial processes. Nowadays, the firm stresses the importance of sustainable development and continuously innovates and refines clean technologies; supporting this drive to reduce environmental impact through green processes. Alfa Laval also endeavours to perform its own operations (calling them green operations) as cleanly and efficiently as possible, and to take environmental aspects into

consideration when developing, designing, manufacturing, servicing and marketing its products.

Project A

This project is concerned with the global supply chain of the US market, whose products were provided from factories located in China and Europe. The driver of such project was a loss of market share due to a low level of service: it was difficult to meet customer requirements because of an inability to forecast demand and of a proliferation of spot contracts. As a consequence, almost 95% of the orders were unforeseen emergencies and required to be dispatched by air freight, with the result to increase the cost of transportation.

The change agent in charge of the project was the global Six Sigma manager with competencies developed in the operations and a long international experience. He led a group of 5 people, following different problems according to the type of background.

The project aimed at changing the global supply chain for products addressed to the US market, by operating on the manufacturing process through the implementation of lean practices. The ultimate result was the reduction of the frequency of air freight to just 5% of the total transportation.

In order to reach such objectives, the project team focused on demand management. As the customers were either OEM (they represent 70% of the total) or big distributors (30%) and the type of product was not subject to particular fluctuations, they found that demand could be forecasted thanks to formal agreements with their major customers. This collaboration opened the possibility to introduce further improvements, mainly along the production process. The sales force was drastically reduced and it was introduced a single supply chain coordinator in

charge of collecting the orders and placed them to Chinese and European factories, according to a make to stock production. Such pull system was supported by the smoothing the type and quantity of production, based on contractual forecasts, and the implementation of a kanban system. As a consequence, any slight fluctuation could be managed thanks to the leveling of the demand, which guaranteed a low level of buffer stock. Finally, all the steps in the production process, included those requiring a mass production, were fully integrated through the introduction of a supermarket. The new production process, along with the ability to forecast orders in advance, allowed for a progressive abandon of air freight towards a massive utilization of ship transportation, although the higher lead time of the latter.

As a result, the cost of the global supply chain recorded a total saving of 30% and shorter lead times, due to the leveling of customer demand, allowing for new sales opportunities. Simultaneously, the implementation of lean manufacturing improved environmental performance, with a reduction of 31,6% in Co2 emissions. In addition, the overall change along the supply chain created room for a sustainable initiative in the packaging process. The standardization of the type of packaging both in China and Europe put in evidence the possibility to eliminate the use of plastic package and replace it with cardboard, by reducing the cost of disposal. According to our interviews, this result was gained thanks to the collaboration of a third-party logistics, provided with the competences and tools necessary to manage cardboard package.

Project B

Case study B is a relative recent project, in which the company decided to dismantle the washing plant, in order to reduce the usage of solvent and limit the emissions inside the

working space.

In the evaporator workshop, the washing plant was used to clean all the parts after mechanical expansion, through the use of solvent. The problem that AL pointed out was the high running costs as long as the environmental impact.

Initially, the yearly cost was composed by gas (40%), solvent consumption (40%), additive (10%) and energy (10%), and the company decided to implement this project in order to reduce the annual cost (initially they didn't think to eliminate the washing plant).

The expected deliverables were to provide working parameters for improving the utilization in term of running cost; it will be also provided a pay-back analysis for all the improvements that request investment approval (possibility to recover energy...).

The washing plant was bought in 1989 and carbon filter regeneration was added in 1993, in order to wash the fins out from the lubricant used in the pressing step and to dry the water used in the tubes expansion process.

However, its role changed during the time: till 1997, when Alfa Laval was focused on coil production, the entire production was processed through the washing plant. In 1997, the introduction of a new line of products, i.e. BIG Air Cooler Condenser, made impossible the utilization of the washing machine due to the dimension, by requiring the adoption of alternative tools, evaporative oil in the pressing steps and the hydraulic expansion; from 2001, the focus was addressed more on Air Heater Exchanger, and in August a big activity was put in place in order to split the production into 2 main buildings, one dedicated to UC and a second one to ACC.

At that time, a further change was introduced in the washing process, by the replacement of the mechanical expander, instead of the water-based one, and the adoption of evaporative oil in the

ACC pressing step. In 2003, a second mechanical expander came in, progressively from that date on all the products has been provided with mechanical expansion facilities, the two technologies also has been put in place in order to decrease plant running cost and skip the washing for as many units as possible.

Alfa Laval recognized some problems relating to the use of the washing plant, in particular, they wanted to do new working parameters (less solvent inside the plant, bath temperature, baskets extraction), solvent at the chimney and in the working area under control, a new condensation plant (no more wasted water), optimization of air extraction and carbon filters.

The investment needed is measuring tools (gas analyzer and counter) and the condensation plant, in order to reduce the number of units to be washed and save 50% of yearly cost.

There were identified two critical aspects to solve the problem: dry the water used with the manual expansion technology and clean out the mineral oil used in the pressing and expansion process.

In order to implement the change in the type of oil, it was important to figure out if customer requirements would be threatened and product quality decreased, with particular attention to thermal performance, time needed the required vacuum level, presence of any kind of oil in the water collected from the defrosting cycles, presence of any kind of oil in the air or in the cell and presence of any kind of fine dust inside the units.

In light of such customer and quality requirements, the company run a test on alternative type of oils in order to find the best match with the critical prerequisite; the test was led by the Thermal Laboratory in Alonte with the support of an external certified laboratory, for the defrosted water analysis and for the air cell analysis.

The results underlined not significant or not critical differences except for the presence of fine

dust inside the units, they found a bit more quantity in the not washed unit.

From a dust concentration (weight) point of view in the washed part, there is around 25% compared to the not washed one; in any case, we are talking of less than 0.5 mg per tube meter in the worst case. From the size point of view of the biggest particle found in the “not washed” is just 5% bigger in terms of diameter. So they have reason to retain this point not so critical into the process.

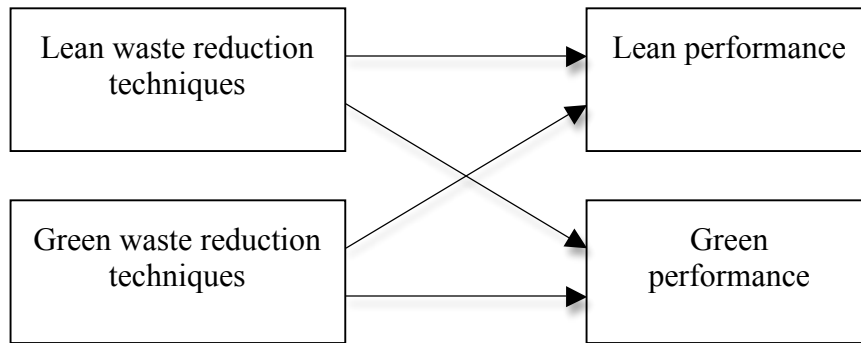
Starting from the working parameter improvements, in 2006, to the elimination of the washing plant, in 2009, the principal benefits achieved, relating to the process, were the reduction of the consumption of energy and solvent, and the decrease of cycle time; in particular, the lead time decreased from five days to three days and half, and the value of work in process was significantly reduced.

The process reengineering gave results in terms of saved space, costs as well as pollution abatement. In fact, 50% of running cost depends on volume washed, the rest is fixed, and the dismantling of the washing plant saved around 250 mq of space.

Discussion

In their article, Bergmiller and McCright (2009) assert that there is a significant synergy between lean and green programs and, in particular, companies that pursuing operational target will be more successful also in pursuing green objectives.

We refer, especially, at the model of a “synergistic relationship between lean and green operations” in which the authors evidence the multiple connections between the two types of practices and the performances.



Our research emphasizes the concept of complementarity in which the sum of the performance of single activity taken in isolation is lower than the performance resulting the simultaneous implementation of different activities.

So we have studied how a firm can conjugate operation management with environmental sustainability and how the two domains can generate synergies and impact performance.

Such complementarity results in our Project B. In particular, we find that the initial objectives are both in a lean and green direction, while the practices implemented by Alfa Laval are in a sustainable perspective.

Referring to Klassen and Whybark (1999), we can underline two different steps: the first one is concerned with pollution control, in which the company introduces tools to measure working parameters and the second one is concerned with pollution prevention, i.e. the elimination of the washing plant.

As we have underlined in the literature review, pollution prevention technologies create value, by using resource more efficiently, and they allow for higher environmental performance with respect to pollution control.

Also, the results of the project B are both operational and environmental: saved space, reduction of annual cost and limitation of buffer units are all improved operational performance, while lowering emissions and the reduction of oil spill are better environmental performances.

In project A, we find that lean objectives have been considered as a starting point and then also some green performances was accrued during the project implementation. Indeed, this project has confirmed prior literature on the positive impact that lean practices have on environmental performance (Shrivastava 1995; Florida 1996; Hart 1997; King and Lenox 2001 Rothenberg et al. 2001). Also the EPA (Environmental Protection Agency) is in line with this assumption, by arguing that “lean companies develop a “waste reduction culture” that is essential to the company embracing Lean or Green manufacturing systems” (EPA, 2007).

In particular, project A highlights that collaboration with customers, the leveling of demand, pull system, the use of kanban and the introduction of a supermarket are all lean practices that increase firm efficiency by reducing any type of waste, including pollution released by the transportation of products. Counting that transportation accounts for more than 40 percent of the company’s total Co2 emissions, the reduction in frequency of air freights has been an important goal for improving the overall environmental performance, where lean practices have represented the main enabler.

In addition, in project A we find that packaging standardization brought to the elimination of plastic packages. We can presume that a lean practice has provided the opportunity to adopt a green practice with the final result of improving environmental performance. Anyway, we can not rule out that the driver of green initiatives has actually been cost savings.

In both projects, it looks like that environmental management generally enters in business

strategies and firm goals only as a corollary consideration with respect to the operational one. Indeed, the interviews have unveiled that managers do not necessarily measure the green effects of their strategies (Dechant et al. 1994, Yu et al. 2009).

In conclusion, our case study represents a further proof that a joint implementation of green and lean practices leads to a better environmental and operational performance and, more interestingly, it contributes to the literature on the complementary effects of the two practices, by demonstrating that an improvement in green performance through the implementation of green operations can determine also higher operational achievements if green is associated with lean management.

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