

Overcoming barriers of green transformation through the adoption of lean manufacturing: a case study

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Abstract: Environmental sustainability is gaining more and more importance all over the world. To cope with this trend, companies are working to align their production models implementing green management practices. However, this implementation involves several challenges and calls for appropriate actions to overcome internal and external barriers. Even though lean manufacturing has been considered by researchers a suitable organisational approach to support environmental transformation, how and to what extent lean components integrate into green transformation remains an unexplored topic. On these premises, this paper tries to bridge the existing gap by performing an in-depth inductive analysis developed in a manufacturing textile company, that, while operating in accordance with lean manufacturing principles, has recently started a green transformation project. The achieved results confirm that green transformation is a continuous process that takes place with the gradual adoption of green management practices. Moreover, the study suggests that distinctive features of lean manufacturing can help organisations overcome specific barriers that emerge at different stages of the green transformation process.

Keywords: Environmental sustainability, lean manufacturing, green management, cases study, textile industry.

1. Introduction

Climate change, water, air and soil pollution and resource depletion are driving many governments, society and people to demand more sustainable economic models. Increasing regulatory pressures and customers' expectations (Rondinelli and Vastag, 1996) are therefore leading many companies to change the way they plan, organize and manage their production systems (de Burgos Jiménez and Lorente, 2001).

Scientific and managerial literature has shown that environmental consciousness is not created instantly, but is the result of a slow and continuous process that takes place through the progressive introduction of green managerial practices (GMPs) (Boffelli et al., 2019), whose adoption may be hindered by several barriers. In this context, many researchers have suggested that the adoption of efficiency-oriented practices can spontaneously pave the way for a greener approach.

In particular, as a methodology oriented towards waste reduction and process optimisation, lean manufacturing has been identified as the natural enabler of environmental sustainability (Martinez-Jurado and Moyano-Fuentes, 2014; Resta et al., 2017). Nevertheless, despite a positive influence of lean manufacturing on environmental orientation (Vinodh et al., 2011), it is not clear yet how and to what extent the integration of lean components into GMPs can help companies overcome the barriers emerging during their environmental transformation.

Based on these premises, this paper proposes a study aiming to understand how and to what extent lean manufacturing facilitates green transformation. The

analysis is carried out by an in-depth investigation of a single case study belonging to the textile sector, following a longitudinal viewpoint in order to capture the temporal support given by lean manufacturing during the progressive introduction and development of green management initiatives.

In the following section, the findings of an in-depth literature review on barriers to green transformation and lean manufacturing distinctive characteristics are presented. Section 3 introduces the methodological approach adopted to conduct the study, while Section 4 presents and discusses the main results of the research. Finally, the conclusions, limitations and future developments are reported in Section 5.

2. Theoretical background

According to the purpose of the study, the analysis of theoretical background has been built around three main parts. The first part proposes an analysis of the extant studies concerning barriers to the implementation of green management. The second part reports a discussion on lean manufacturing and its distinctive features. Finally, the last section proposes the review of the literature regarding the integration of lean and green paradigms.

2.1 Barriers to green management

The growing attention of society and governments to environmental issues is prompting many modern companies to question their environmental strategies by adopting consistent GMPs. The latter refers to all actions

that companies can implement to reduce their environmental impact (Sroufe et al., 2002). Different methods have been proposed over the years to categorize GMPs. Sroufe et al. (2002) grouped them into operational, tactical and strategic areas. While operational dimension concerns rules adopted to optimise resource allocation and utilisation as well as to reduce wastes, tactical practices encompass supply chain management, product and process design and development and recognition of environmental performances. Finally, the strategic perspective involves all those practices that are implemented to enhance competition. Lucas (2010) categorized GMPs along with two main dimensions: the type of capital investment and the stages at which practices affect the production process. Moreover, Colicchia et al. (2013) argued that GMPs can be distinguished into intra-organizational, namely practices related to internal business processes, and inter-organizational, i.e. practices which involve collaboration among different entities within the supply chain. Finally, Resta et al. (2014), provided a classification framework for textile, clothing and leather industry including 57 GMPs grouped in 6 areas, i.e. products and services, supply chain management, production process, culture, governance and others.

Even though the introduction of GMPs brings competitive advantage (Shrivastava and Scott, 1992), literature has underlined that several barriers can hinder their adoption. According to the study conducted by Hillary in 2004, subsequently supported by Kehbila et al. (2009), barriers to the introduction of green management initiatives can have an internal or external perspective. As reported in Table 1, internal barriers correspond to all factors that prevent the introduction and implementation of green initiatives and that arise within the company. External barriers (described in Table 2), instead, refer to obstacles coming from outside the company. Moreover, existing studies (Jabbour et al., 2016) agree that the former is more significant than the latter.

Table 1: Internal barriers to green management implementation

Category	Description
Resource	Low awareness of human resources, unskilled personnel and inadequate financial resources.
Understanding and perception	Lack of awareness about benefits and perception of high costs for implementation and management.
Implementation	Uncertainty on how to maintain and continuously improve practices over time.
Attitudes and company culture	Inconsistent support of top management and aversion to support innovative but high risky projects

Table 2: External barriers to green management implementation

Category	Description
Certifiers/verifiers	High costs of certification and lack of experienced verifiers.
Economics	Scarce economic benefits, low level of external stimuli and changing of priorities imposed by the context.
Institutional weaknesses	Lack of accessible financial support and scarce clarity on environmental legislation.
Support and guidance	Unavailability of consulting services and absence of trade association for implementation support.

To overcome these obstacles, different types of solutions can be implemented (Gupta and Barua, 2018). They include the design of specific pollution reduction policies, the introduction of incentives and tax cuts by the government (Govindan et al., 2016; Kiss et al., 2013), the setting of environmental management systems, like ISO 14001, for monitoring environmental practices (Somsuk and Laosirihongthong, 2016), the focusing on recovery, the development of redeployment and reselling strategies in order to recoup investments (Lee et al., 2014).

2.2 Lean manufacturing

In the last decades, companies have experimented several efficiency-oriented approaches to achieve profit maximization of their operations, e.g. work study, operations research and business process reengineering (Grünberg, 2004). Among others, lean manufacturing, defined as “an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability” (Shah and Ward, 2007) is commonly recognized as one of the best methods of operations management (Bhasin, 2012). It plans to act simultaneously at both a strategic and an operational level by means of different practices that, according to Shah and Ward (2003), can be divided into four complementary groups: Just-in-Time (JIT), Total Preventive Maintenance (TPM), Total Quality Management (TQM) and Human Resource Management (HRM).

Although the adoption of lean practices is globally recognised as one of the most effective, many lean projects have failed dramatically or lead to results significantly lower than expected (Bhasin and Burcher, 2006). According to Logaarda et al. (2016), the main causes of failure can be divided into four categories: management, knowledge, organisation, tools and practices. In particular, scientific and managerial literature, formalizing some theories on the effective implementation of lean systems, has shown that lean success can arise only when the application of lean

principles is interpreted as a learning process aimed at supporting the continuous improvement (Bode and Mueller, 2012). Indeed, research has underlined that the secret of lean success is not based on hard methods and techniques, but rather on its ability to overcoming the organisational rigidity typical of manufacturing companies, exploiting human and technical resources through their interaction and involvement (Badurdeen et al., 2010). Such approach can be summarized in the so-called “Toyota Way”, a special way of seeing, thinking and acting based on the centrality of people on the one hand and the continuous improvement on the other (Lander and Liker, 2004). In the end, implementing real lean manufacturing requires simultaneous efforts in many dimensions, as described by the 4P model (Liker, 2004), which includes:

Philosophy

The adoption of an organizational philosophy centred on the principles of lean thinking requires a long-term orientation based on genius, creativity and the courage to challenge daily markets and competitors. For this reason, it is always necessary to remain focused, work tenaciously, listen to the others and learn from mistakes.

People

The desire to contribute to society by providing better products and services and by fostering the development of collective well-being is reflected in the commitment of each member of the organisation. Mutual respect and trust are placed at any level, while activities are carried out together to stimulate both personal and professional growth, as well as to create opportunities for improvement of both individuals and groups.

Process

A lean organisation works on the elimination of process wastes, through the standardization of operations and the evaluation of how improvements have been achieved rather than what results have been reached.

Problem-solving

The Genchi Genbutsu, which literally means go to the source of value and verify the facts, is the criteria that naturally leads people who apply lean manufacturing. Being present where a problem is generated is the first step to create each other's respect, eliminate misunderstandings and facilitate teamwork.

2.3 Integrating Lean and Green

Literature discloses the existence of synergies based on the joint implementation of lean and green practices (Tice et al., 2005; Galeazzo et al., 2013; Wiese et al., 2015; Garza-Reyes, 2015; Resta et al., 2016). As argued by Hansen et al. (2004) “*while Lean practices can lead to environmental benefits, inversely environmental practices often lead to improved Lean practices*”. In particular, the two concepts are complementary and overlap on three main areas, i.e. waste reduction, process-oriented focus and people involvement (Martinez-Jurado and Moyano-Fuentes 2014). While lean manufacturing aims at increasing value for all stakeholders

by eliminating activities that do not bring value, GMPs focus on process optimization, as a means to reduce environmental pollution. Furthermore, the two approaches highlight the necessity to prevent mistakes and to avoid their recurrence through the involvement of people in principles and practices implementation. Moreover, as claimed by Dües et al. (2013), the two initiatives have in common the achievement of lead time reduction, development of supply chain relationship and service level improvement.

3. Research Design and Methodology

According to Yin (2009), a single case study can offer a significant contribution to knowledge and theory building when complex interactions between different variables under observation must be analysed, avoiding a superficial approach that typically characterises multi-case analyses (Dyer and Wilkins 1991). Moreover, as suggested by Voss et al. (2002), single case approaches demonstrate more effective learning on cause and effect relationships when taking a longitudinal perspective.

As the aim of this research is to understand how and to what extent lean manufacturing approaches might help companies in overcoming barriers when introducing GMPs practices in their green transformation, a single longitudinal and retrospective case study was considered the most appropriate research method to follow.

The company under investigation (from now referred to as Alpha) is a leading carpet manufacturer located in Northern Italy, whose mission is focused on technology, know-how and the “Made-in-Italy” values. Part of a large international group, Alpha accounted in 2018 a turnover of about € 51 million. Its production, reaching a global scale, serves several markets, among others residential building, hotels, offices, ships, aircraft, sports facilities and vehicles. After embracing the lean philosophy in 2013, the company has significantly improved its operational performance, profit margins and competitive advantage. The decision to analyse a textile company was made because this sector undoubtedly represents a context worthy to be studied. Indeed, it represents one of the world's most polluting industries (European Commission, 2013), but also one of those characterized by the greatest efforts towards the creation of sustainable production models (Ellen MacArthur Foundation, 2017). To attain the research objective data were collected through semi-structured interviews developed around a research protocol built upon a literature review. The latter was carried out to delve into theoretical aspects on barriers towards green transformation, lean manufacturing dimensions and their role in supporting environmental transformation. The semi-structured interviews were conducted following a three steps process: selection of interviewees, execution of interview and transcription of results. The interviewees were selected among managers who actively participated in the implementation of lean manufacturing initiatives or in the introduction of GMPs within the company. Each interview, which lasted between 90 and 120 minutes, was done face-to-face by two researchers and was recorded in order to increase the

internal reliability of the study (Yin, 2009). After a brief introduction of the main stages characterizing implementation of green and lean initiatives, the interviews continued discussing on the main barriers which came up along the green transformation. Triangulation with Alpha’s secondary sources as website and reports (Scandura and Williams, 2000) was carried out to further check the internal consistency of the achieved information. Consistency of the collected information and their adherence were evaluated independently and cross-checked by the researchers, to minimize biases and reach consensus (Baxter and Jack 2008). Once the agreement among the researchers was reached, final results were presented to the company management for discussion refinement.

4 Results

4.1 Main stages of lean implementation

The implementation of lean manufacturing started in 2013. Initially, it covered a few areas of the shop floor and was progressively extended to the whole company. Some lean tools were introduced to improve production efficiency: 5S for the reorganization of production areas, Kanban for material management and SMED for minimizing setup times. Subsequently, the company implemented an integrated performance measurement system in order to control the overall equipment effectiveness (OEE). At the same time, the company developed the principles of lean thinking through the implementation of some soft practices. For instance, an attempt was made to involve internal workers through specific training activities while teamwork initiatives were launched to enhance participation and problem-solving. This approach was subsequently extended to the whole supply chain, progressively involving external partners and key suppliers. The direct participation of the top management from the early stages of the project implementation was also fundamental. The CEO defined a long-term strategy aimed at improving the competitive position of the company and introduced Hoshin-Kanri tools to achieve long-term objectives.

4.2 Main stages of green implementation

When the implementation of lean manufacturing initiatives started, the company was not yet pursuing an environmental sustainability strategy. However, in the following years, the importance of green issues began to be perceived by the company’s top management, who decided to adopt ISO 14001 certification, a voluntary international standard that specifies the requirements of an environmental management system, in order to improve company image and align with legislative compliance.

In the second step, the company started introducing some actions to improve process sustainability. In particular, the top management developed a long-term plan of investments to replace all equipment with new and more efficient solutions to reduce the energy consumption, thus ensuring additional economic resources to reinvest in new

environmental projects. Some GMPs aimed at optimizing the processes were also activated, e.g., waste and scrap recovery, while a new monitoring system dedicated to the control and assessment of the environmental impact on air, water and soil was implemented in order to enhance the improvement of environmental performance. Besides, Alpha has launched an eco-friendly product on the hospitality market.

After observing a first significant improvement of its environmental performances, the company decided to involve both internal and external partners in the green adoption process. Specifically, it began to involve and empower its employees as well as to establish collaboration agreements with certified and environmentally sensitive suppliers. In addition, where possible, it shortened its supply chain to reduce logistic environmental impact. In 2018, the company launched a communication plan of its green activities through various channels, including its website which currently has a specific section dedicated to sustainability. In the same year, Alpha decided to adopt the Ecolabel-Leed, a voluntary certification score system for assessing the level of environmental sustainability of its buildings. In addition, the company started publishing a yearly sustainability report and joined the Ellen MacArthur Foundation, the foundation that theorized the principles of the circular economy.

4.3 How lean manufacturing assists in overcoming the barriers to green transformation

The green transformation pursued by Alpha allows drawing some considerations on barriers encountered during GMPs implementation and how the adoption of lean manufacturing principles helped the company overcome them.

A factor that generally could harm a green transformation process is the lack of awareness of top managers about the potential benefits coming from GMPs’ adoption. Such a propensity is often combined with a strong aversion to execution, due to high investment costs associated with GMPs implementation. In this case, although Alpha was forced to undertake green management initiatives due to external pressures, its transformation process did not stop once the minimum requirements imposed by the regulation (such as obtaining ISO 14001 certification) were met. On the contrary, the company continued the implementation process led by the CEO who immediately understood the potential benefits of a sustainable path. According to the principles of the lean philosophy, based on a long-term strategy (Hoshin-Kanri) translated into frequent short-term projects characterized by clear and feasible objectives, Alpha’s top management implemented a multi-year project establishing a monetary budget and identifying the appropriate level of technical and human resources. The program was developed adopting a gradual approach, to stimulate middle management and workers’ cultural change and learning, avoiding introducing stress in the organization and creating the right climate for the implementation of green practices in a more linear and

simple way. In particular, Alpha pursued its green transformation process by gradually introducing GMPs. At first, the focus was on optimizing products and internal operating processes, through the adoption of value stream analysis acquired during the lean experience. Then, the company started to expand its green horizon towards a broader vision of sustainability, mainly achieved through the introduction of practices affecting the management of the supply chain. Finally, the company began to develop communication and reporting systems at the corporate level to expand green culture and orientation from an operational to a strategic perspective.

Nevertheless, other critical issues arose during GMPs implementation. In particular, some difficulties emerged in reorganizing the processes from an environmental point of view. In addition, the company struggled to find the right skills to pursue green practices. However, the Alpha’s lean orientation made it easier to overcome these two barriers. As also underlined in previous research studies (Garza-Reyes, 2015), the process and continuous improvement orientation allowed Alpha to implement new green processes quickly and effectively. Thanks to the teamwork experience gained in previous lean manufacturing projects, it was easy for Alpha to involve people from different functions in the analysis, optimization and implementation of green processes, thus enhancing environmental change in a short time. At the same time, the difficulties encountered in the search for specialistic skills were overcome thanks to the lean experience gained over the years. The predisposition to search for value typical of lean thinking led Alpha to implement temporary solutions to immediately exploit the value contained in the implementation of green initiatives. For instance, Alpha solved its deficit of skills by turning to external consulting services. At the same time, it started to develop internally the necessary skills to avoid long-term dependence on external suppliers. However, this approach did not encounter any obstacles among workers, as the vision of continuous improvement and daily learning is an integral part of a lean organization.

Once the new internal processes were consolidated, the company understood that the transformation process should have involved external partners by sharing GMPs throughout the supply chain. The natural predisposition of Alpha to change, according to the principles of kaizen (“If there is no action there can be no success”) allowed to avoid uncertainties on how to maintain and continuously improve practices over time. In particular, training and information sharing with suppliers and key partners were crucial. Like any lean organization, Alpha demonstrated to be open to knowledge sharing, which it considers an essential prerequisite for real integration. Moreover, the propensity to listen and develop common standards, that are fundamental elements in any lean project, allowed the company to quickly identify effective actions for continuous improvement of green processes within the supply chain.

A further problem that usually arises during the implementation of GMPs is that they are often perceived as non-priority. Therefore, they are often interrupted to

give space to those activities that are considered as fundamental at that particular time. Again, Alpha’s lean attitude made it possible to avoid this risk. The strong support from the top management reinforced by effective internal and external communication, the definition of clear and achievable objectives, the provision of sufficient resources to support the project over time, allowed every involved function and their resources staying focused even in critical periods. As a consequence, the last phase of the transformation process, i.e. the application of green principles at corporate level, did not turn out to be complicated, because it was perceived by the different actors involved both internally and externally as a natural and logical step.

4.4 Discussion

This case study highlights how long and complex the journey towards environmental sustainability is for companies, as it requires to face numerous challenges. Nevertheless, the case reveals that lean manufacturing principles can help companies overcome several organizational, management and cultural barriers that arise during the implementation of GMPs. In particular, the study shows that different methodologies of lean manufacturing expressed in Liker’s 4P model can be adopted individually or in combination to help management remove specific obstacles. Therefore, it can be said that lean production enables an environmental growth path through the creation of a favorable managerial environment. As summarized in Table 3, companies adopting lean principles are facilitated in their green transformation process, as they are characterized by suitable organizational configuration and right attitude to change, thanks to a long-term vision, continuous learning approach and widespread leadership.

Table 3: How lean manufacturing assists in overcoming the barriers to green transformation

Philosophy	Readiness of top management to invest monetary and human resources supports project development in the long term. Moreover, proper communication and gradual approach to change avoid stress in the organization. Finally, development lean culture assists in maintaining commitment and focus even in critical periods.
People	The involvement of internal and external resources at every stage of the green transformation project allows to identify effective actions to maintain competitive advantage in the long term.
Process	Process orientation and standardization leads to improved environmental performance by

Problem solving

avoiding the creation of new waste or the expansion of existing waste.

Kaizen orientation enables companies to implement green process practices faster and more efficiently, as it allows to eliminate the uncertainties related to the maintenance of GMPs over time.

5 Conclusion, limitations and future research

Through an inductive analysis performed in a textile company, this paper explores the role of lean manufacturing as enabler of green transformation, highlighting some theoretical and practical conclusions. First, the paper results confirm that green transformation is a slow and continuous process that takes place through the progressive adoption of GMPs. Second, the findings show that pursuing environmental sustainability requires continuous commitment and effort, which can arise only if every level of the organization is ready to change. In such a context, lean manufacturing plays an essential role in creating the ideal conditions for successful green transformation, as it promotes a continuous integration of technical and organizational skills and stimulates co-participation and search for perfection at different levels within the organisation. Moreover, lean implementation involves a strong cultural change, leading companies and their partners in a process of continuous improvement. Finally, the achieved results can be fundamental for practitioners as they suggest to managers how to integrate different components of lean manufacturing to enhance implementation of GMPs. Nevertheless, this study presents some limitations typical of qualitative research. In particular, as it refers to a single case, a larger sample of companies should be explored to consolidate achieved results and considerations. Moreover, as the research was conducted within a specific sector and country, the analysis should be extended to other industries and countries to validate its applicability in different contexts.

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