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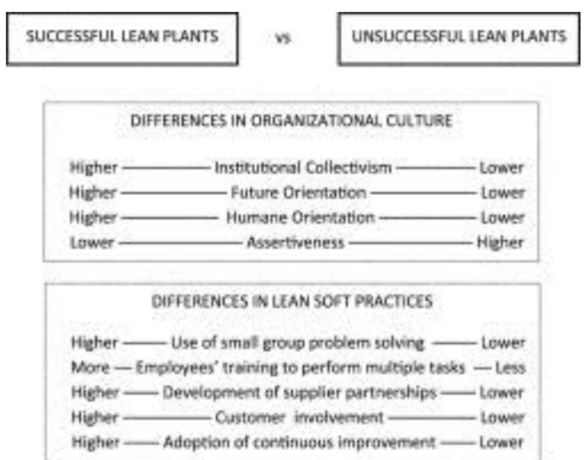
Successful lean implementation: Organizational culture and soft lean practices

Abstract

Lean management (LM) is a managerial approach for improving processes based on a complex system of interrelated socio-technical practices. Recently, debate has centered on the role of organizational culture (OC) in LM. This paper aims to contribute to this debate by examining whether plants that successfully implement LM are characterized by a specific OC profile and extensively adopt soft LM practices. Data were analyzed from the High Performance Manufacturing (HPM) project dataset using a multi-group approach. The results revealed that a specific OC profile characterizes successful lean plants; in particular, when compared to unsuccessful lean plants, they show a higher institutional collectivism, future orientation, a humane orientation, and a lower level of assertiveness. While a high level of institutional collectivism, future orientation, and humane orientation are common features of high performers in general, a low level of assertiveness is typical only of successful lean plants. In addition, successful lean plants use soft LM practices more extensively than unsuccessful lean plants (i.e., lean practices concerning people and relations, such as small group problem solving, employees' training to perform multiple tasks, supplier partnerships, customer involvement, and continuous improvement), while they do not differ significantly in terms of hard LM practices (i.e., lean technical and analytical tools). For managers, the results indicate that, in order to implement LM successfully, it is fundamental to go beyond LM technicalities by adopting soft practices and nurturing the development of an appropriate OC profile.

Graphical abstract



Keywords

- Lean management;
- Organizational culture;
- Operational performance;
- High performance manufacturing;
- Multi-group analysis.

1. Introduction

Lean management (LM) is a powerful managerial approach widely recognized as improving the overall operational performance of a company (Shah and Ward, 2003 and Liker, 2004). Driven by the success achieved by Toyota and several other lean organizations worldwide, a growing number of firms have adopted LM practices to satisfy market needs, reduce costs, and gain an edge over competitors. However, in spite of the LM projects, several companies failed to achieve a superior performance through LM. Operations management (OM) scholars discussed several causes of this lack of success, namely, the complexity of LM implementation (Lander and Liker, 2007), the existence of contingency factors limiting its positive impact (Bortolotti et al., 2013), the focus on Just-In-Time (JIT) practices without adequate consideration of other important OM dimensions (Matsui, 2007 and Agarwal et al., 2013), and the lack of attention paid to human resource management (HRM) (Bateman, 2005 and Agarwal et al., 2013).

This work focuses on two critical success factors for lean implementation: the organizational culture (OC) and the adoption of soft practices. They represent an interesting area of research for several reasons. Some authors have pointed to OC as the cause of the poor effectiveness of LM (Liker, 2004, Sim and Rogers, 2009, Atkinson, 2010 and Liker and Rother, 2011). Based on this assumption, the relation between OC and some bundles of LM practices was empirically studied, e.g., total quality management (Prajogo and McDermott, 2005, Naor et al., 2008 and Baird et al., 2011), and JIT (Yasin et al., 2003). However, these contributions are fragmented and show significant limitations. The first limitation is linked to the narrow set of OC dimensions, LM practices, and performance considered. In-depth understanding of the role of OC in successfully implementing LM requires a comprehensive view of the phenomenon, which should be based on a holistic model comprising the various dimensions of OC, LM, and performance. In addition, most researchers studied OC as an antecedent of LM practices; however, other scholars (e.g., Narasimhan et al., 2012; Wincel and Kull, 2013) have advanced arguments for more complex relationships between OC and LM practices, thus making an investigation that uses a configurational approach more appropriate (Flynn et al., 2010). Moreover, previous contributions providing a more comprehensive analysis of the phenomenon (e.g., Spear, 1999, Liker, 2004 and Rother, 2009) generally focused on the Toyota case history, without leveraging well-established OC models.

A further important issue in LM implementation is the adoption of soft practices. Lean management is generally considered as an interrelated system of soft and hard practices (Shah and Ward, 2007), and in line with this definition and several previous studies (e.g., Prajogo and McDermott, 2005, Rahman and Bullock, 2005, Fotopoulos and Psomas, 2009 and Calvo-Mora et al., 2013), in this research LM practices are referred to as soft and hard. Soft practices concern people and relations, while hard practices refer to LM technical and analytical tools. Soft practices are crucial for achieving superior performance through LM (Samson and Terziovski, 1999 and Matsui, 2007) and sustaining the performance in the long term (Hines et al., 2004), even though organizations sometimes do not give equal importance to soft and hard tools, by focusing their efforts on lean technical tools only (Liker and Rother, 2011).

The aim of this study is to investigate whether lean plants that successfully implement LM have a specific OC and adopt soft LM practices more extensively compared to lean plants that do not implement LM successfully. In this research, we identified lean plants based on the managers' perceptions of the overall level of lean application in the plant compared to competitors. We chose this approach, rather than classifying lean plants based on the lean techniques implemented, because it allows us to understand whether plants with a high level of lean adoption according to managers' perceptions really implement soft and hard practices or whether a distinction among plants, which managers judge to be lean, can be made. In fact, although authors agree that lean is a complex system of soft and hard practices (Shah and Ward, 2007), LM projects within companies and managers' perceptions of what implementing lean means can differ significantly. Although many managers understand the importance of implementing hard lean techniques, not all emphasize implementing soft practices (Liker, 2004 and Liker and Rother, 2011). To assess LM success and thus distinguish between successful and unsuccessful lean plants (labeled high- and low-performance lean plants), we considered plants' operational performance in terms of cost, quality, delivery, and flexibility compared to their competitors. This choice is in line with the widespread view that lean improves different performance dimensions at the same time, as the trade-offs that usually characterize a plant's competitive capabilities can be overcome (Shah and Ward, 2003). However, high performance per se is not synonymous with LM success. Therefore, in this research we used several control variables to significantly reduce the risk of endogeneity (i.e., the risk that high performance was achieved without lean). We preferred to avoid using perceptual or quantitative

measures of improvements obtained through LM as a proxy for LM success, because these measures can be difficult to compare across plants.
With this study, we intend to contribute in several ways to the debate on the importance of OC in implementing LM. First, compared to previous studies, the present work aims to develop a more comprehensive understanding of the phenomenon by considering various dimensions of OC, LM, and performance, rather than focusing on a specific set of variables, and by relying on a well-established OC model, the Global Leadership and Organizational Behavior Effectiveness (GLOBE) model (House et al., 2004). In addition, by investigating differences in OC dimensions between successful and unsuccessful lean plants, we can identify whether and which OC dimensions make a difference, instead of simply evaluating which OC dimensions act as enablers/antecedents of LM. Finally, by investigating differences in LM soft practices, we intend to further analyze the role of these practices in implementing LM successfully.
The paper is organized as follows. First, we review the existing literature on OC, LM, and the relationship between LM and performance and develop research hypotheses. Section 2 presents the data collection, research sample, variables and scales used, and analyses run. This is followed by the discussion of the results found, research limitations and opportunities, and the conclusion.

2. Literature review

2.1. Organizational culture

The advent of culture in organizational theory discipline is quite recent and generally ascribed to Pettigrew (1979)'s seminal article, published in the *Administrative Science Quarterly* (Hofstede et al., 1990). Although this study and other early theoretical contributors such as Baker (1980) and Hofstede et al. (1990) played a decisive role in drawing scholars' attention to OC, practitioners' interest focused mainly on Ouchi's (1981), Peters and Waterman's (1982), and Deal and Kennedy's (1982) books. As a whole, these contributions sparked a culture revolution that until today has resulted in numerous organizational studies on the role of culture within organizations.
Various conceptualizations of OC have been provided by scholars over the years (Detert et al., 2000 and Jung et al., 2009). Although a widely accepted view is still lacking in the literature, several similarities can be found among the different definitions provided (Denison et al., 2012). In general, OC is defined as a "combination of artifacts (also called practices, expressive symbols, or forms), values and beliefs, and underlying assumptions that organizational members share about appropriate behavior" (Detert et al., 2000, page 851).
Based on an in-depth literature review of the instruments used for exploring and assessing OC, Jung et al. (2009) concluded that numerous tools have identified more than 100 dimensions associated with OC. The measurement models developed by Quinn and Rohrbaugh (1983), Schein (1984), Hofstede et al. (1990), O'Reilly et al. (1991), and House et al. (2004) are some of the most renowned and frequently used. In this study, we adopted the GLOBE model of OC (House et al., 2004). GLOBE is a research project developed by a group of about 150 social scientists and management scholars worldwide to define a culture measurement model and analyze the impact of culture on leadership, organizational processes, and performance (House et al., 2004). We chose this tool for several reasons. First, the GLOBE project represents a milestone in operationalizing the OC concept. Based on an extensive literature review, the GLOBE project proposes and empirically tests, through advanced modeling techniques, a comprehensive culture measurement model including several dimensions, each measured with a multi-item scale. Compared to other studies, a further relevant and recognized contribution of the GLOBE model is that it proves cultural dimensions are homologous across different levels of analysis (i.e., national and organizational levels), and thus are appropriate for studying national culture (NC) and OC. This might facilitate theory building on this issue, by making different studies more comparable. Second, we chose the GLOBE model because of the affinity between House's et al. (2004) objectives and the aims of the present study. According to Jung et al. (2009), this fundamental criterion should guide the choice of a measurement model. In fact, one of the main aims of the GLOBE conceptualization of OC was analyzing how culture affects organizational practices and their effectiveness (House et al., 2004). Finally, international collaboration in developing an OC instrument can facilitate its transferability across different settings (Jung et al., 2009). Given that our study uses data collected from plants in different contexts (Section 3.1), we think that using a transferable instrument, such as the GLOBE model, is especially relevant.

Table 1 reports the nine cultural dimensions developed by the GLOBE project. They apply to organizational and societal levels (House et al., 2004). In fact, questioning the position of researchers who consider NC and OC different phenomena (e.g., Hofstede et al., 1990), the GLOBE project explores the cultural dimensions at the societal and organizational levels and concludes that the set of nine dimensions can examine both NC and OC (see House et al., 2004, chapter 5). Starting from the GLOBE project, for instance, Naor et al. (2010) used GLOBE dimensions to measure NC and OC and evaluate their impact on firm performance.

Table 1.The culture dimensions considered (organizational level in italics).

Culture dimensions	Definitions
Power distance	The degree to which members of *an organization* or society expect and agree that power should be stratified and concentrated at higher levels of an organization
Institutional collectivism	The degree to which *organizational* and societal institutional practices encourage and reward collective distribution of resources and collective action
In-group collectivism	The degree to which individuals express pride, loyalty, and cohesiveness in *their organizations* or families
Future orientation	The degree to which individuals in *organizations* or societies engage in future oriented behaviors such as planning, investing in the future, and delaying individual or collective gratification
Performance orientation	The degree to which *an organization* or society encourages and rewards group members for performance improvement and excellence
Gender egalitarianism	The degree to which an *organization* or society minimizes gender role differences while promoting gender equality
Assertiveness	The degree to which individuals in *organizations* or societies are assertive, confrontational, and aggressive in social relationships
Uncertainty avoidance	The extent to which members of *an organization* or society strive to avoid uncertainty by relying on established social norms, rituals, and bureaucratic practices
Humane orientation	The degree to which individuals in *organizations* or societies encourage and reward individuals for being fair, altruistic, friendly, generous, caring, and kind to others

Source: House et al. (2004).

We focus on OC, and thus adopt the GLOBE dimensions at the organizational level. More precisely, the unit of analysis is the plant; thus, we measured the OC inside plants. In addition, in line with other studies (Aksu, 2003, Kull and Wacker, 2010 and Naor et al., 2010), we did not include the gender egalitarianism dimension.

2.2. Lean management

Lean management, a methodology whose notoriety exploded thanks to Womack et al. (1990) work "The Machine That Changed the World" was born from Just-In-Time and the Toyota Production System (TPS), inheriting their core characteristics (Schonberger, 2007 and Olhager and Prajogo, 2012). In the literature, LM is viewed through either a strategic/philosophical (e.g., Womack and Jones, 1996 and Upton, 1998) or operational/technical lens (e.g., Shah and Ward, 2003 and Shah and Ward, 2007). These perspectives are closely related. One literature stream considers LM a philosophy that follows five principles (value, value stream, flow, pull, and perfection) to eliminate all sources of waste (or *muda*) from the production processes (Womack and Jones, 1996), while a second stream translates the lean philosophy using a more concrete perspective. In this point of view, LM is interpreted as a managerial system that integrates specific practices and techniques to reduce internal and external process variability, also called *mura*, recognized as the principal source of production problems from a lean standpoint (Shah and Ward, 2007).

Over the years, this LM interpretation has led to many studies on LM operationalization. Among the most relevant and complete is the work by Flynn et al. (1995), Cua et al. (2001), Shah and Ward, 2003 and Shah and Ward, 2007. Shah and Ward (2003)identified relevant internal LM practices and divided them into JIT, total quality management (TQM), HRM, and total preventive maintenance (TPM) bundles. The same authors then extended their model by including internal-related practices (*kanban*, continuous flow, setup time reduction, TPM, statistical process control, and employee involvement) and supplier- and customer-related practices, such as JIT deliveries and supplier and customer involvement (Shah and Ward, 2007). Flynn et al. (1995) and Cua et al. (2001) emphasized the importance of human-related practices in conducting continuous improvement programs, such as top management leadership for quality, small group problem solving, and employee training. Table 2 summarizes the practices used to operationalize LM according to the relevant works in the LM literature (i.e., Flynn et al., 1995, Cua et al., 2001, Shah and Ward, 2003 and Shah and Ward, 2007).

Table 2. Hard and soft LM practices.

Practice	LM literature	Literature on hard/soft practices	Hard/soft LM practice
Setup time reduction	Flynn et al. (1995), Cua et al. (2001), Shah and Ward (2003), Shah and Ward (2007), Matsui (2007),Mackelprang and Nair (2010)	Rahman and Bullock (2005)	Hard LM practice
JIT delivery by suppliers	Cua et al. (2001), Shah and Ward (2007), Matsui (2007),Mackelprang and Nair (2010)	Rahman and Bullock (2005)	Hard LM practice
Equipment layout for continuous flow	Cua et al. (2001), Shah and Ward (2003), Shah and Ward (2007), Matsui (2007),Mackelprang and Nair (2010)	Rahman and Bullock (2005)	Hard LM practice
Kanban	Flynn et al. (1995), Cua et al. (2001), Shah and Ward (2003), Shah and Ward (2007), Matsui (2007),Mackelprang and Nair (2010)	Rahman and Bullock (2005)	Hard LM practice
Statistical process control	Flynn et al. (1995), Cua et al. (2001), Shah and Ward (2003), Shah and Ward (2007), Matsui (2007)	Samson and Terziovski (1999), Rahman and Bullock (2005), Taylor and Wright (2006), Fotopoulos and Psomas (2009)	Hard LM practice
Autonomous maintenance	Cua et al. (2001), Shah and Ward (2003), Shah and Ward (2007), Matsui (2007),Mackelprang and Nair (2010)	–	Hard LM practice
Small group problem solving	Flynn et al. (1995), Shah and Ward (2007), Challis et al. (2005), Matsui (2007)	Samson and Terziovski (1999), Lagrosen and Lagrosen (2005), Prajogo and McDermott (2005), Rahman and Bullock (2005), Taylor and Wright (2006),Fotopoulos and Psomas (2009)	Soft LM practice
Training employees	Flynn et al. (1995), Cua et al. (2001), Shah and Ward (2003), Shah and Ward (2007), Matsui (2007)	Samson and Terziovski (1999), Lagrosen and Lagrosen (2005), Prajogo and McDermott (2005), Rahman and Bullock (2005), Taylor and Wright (2006),Fotopoulos and Psomas (2009)	Soft LM practice
Top management leadership for quality	Flynn et al. (1995), Cua et al. (2001), Matsui (2007)	Samson and Terziovski (1999), Lagrosen and Lagrosen (2005), Prajogo and McDermott (2005), Taylor and Wright (2006), Fotopoulos and Psomas (2009)	Soft LM practice
Supplier partnership	Flynn et al. (1995), Cua et al. (2001), Shah and Ward (2007), Matsui (2007)	Rahman and Bullock (2005), Fotopoulos and Psomas (2009)	Soft LM practice
Customer involvement	Flynn et al. (1995), Cua et al. (2001), Shah and Ward (2007), Matsui (2007)	Samson and Terziovski (1999), Prajogo and McDermott (2005), Rahman and Bullock (2005), Taylor and Wright (2006),Fotopoulos and Psomas (2009)	Soft LM practice
Continuous Improvement	Shah and Ward (2003),Matsui (2007)	Samson and Terziovski (1999), Lagrosen and Lagrosen (2005), Fotopoulos and Psomas (2009)	Soft LM practice

Another interesting approach for studying LM is classifying practices as hard or soft (Samson and Terziovski, 1999, Rahman and Bullock, 2005 and Fotopoulos and Psomas, 2009). Table 2 shows how LM practices can be classified into hard and soft practices according to the literature. Although finding perfect correspondence across all the studies is impossible, we applied a similar criterion in defining the characteristics of and differences between these two bundles. In line with previous studies, we argue that the technical and analytical tools introduced to a firm to improve production systems represent hard practices (e.g., statistical process control or kanban) while practices related to principles, managerial concepts, people, and relations are soft (e.g., continuous improvement, top management leadership, customer and supplier involvement). Autonomous maintenance was not classified by previous studies as a hard or soft practice. According to these definitions, in this study, we considered autonomous maintenance a hard practice.

2.2.1. Lean management and the link to performance

The majority of empirical studies supports the overall positive impact of LM on a firm's operational performance (Moyano-Fuentes and Sacristán-Díaz, 2012). The main benefits consist of reducing process variability, scraps, and rework time, which in turn reduce production costs and lead times and increase process flexibility and quality conformance.

Cua et al. (2001) stressed the importance of using JIT, TQM, and TPM simultaneously when implementing LM. TPM tools play a strategic role not only in directly gaining better performance but also in preparing the right environment for efficient adoption of JIT and TQM techniques (McKone et al., 2001 and Mackelprang and Nair, 2010). The importance of these so-called hard practices is emphasized in Taylor and Wright's (2006)study. The authors empirically showed that the hard part of the TQM methodology is a strong predictor of manufacturing performance improvements. The efficacy of hard practices is especially magnified when they are coherently accompanied by intangible and soft practices, linked to HRM (Matsui, 2007), management leadership and support (Samson and Terziovski, 1999 and Matsui, 2007), and customer and supplier involvement (Rahman and Bullock, 2005, Matsui, 2007 and Romano and Formentini, 2012). The effectiveness of implementing joint hard and soft LM practices was also supported by the results of Shah and Ward's (2007) study, in which the authors depicted LM success as the result of a complex system of interrelated socio-technical practices.

However, in the literature there are also examples of LM failures. The lack of significant performance gains is typically blamed on the complexity of implementing LM due to possible negative synergies between JIT tools and techniques (Mackelprang and Nair, 2010), implementing JIT without adequately considering other OM practices and a coherent long-term manufacturing strategy (Matsui, 2007 and Agarwal et al., 2013), or difficulties adapting JIT to particular contexts (e.g., non-repetitive contexts, Lander and Liker, 2007). However, JIT is not the only source of LM failure. As pointed out by Liker and Rother (2011), several lean programs fail because of a company's superficial approach. Many firms focus on implementing lean tools and techniques (i.e., hard practices) but pay little attention to human-related practices (i.e., soft practices) (Hines et al., 2004 and Liker and Rother, 2011). Evidence also points to the OC as a key determinant of LM success or failure (Liker, 2004, Sim and Rogers, 2009, Atkinson, 2010 and Liker and Rother, 2011). Thus, Section 2.3 deepens the debate on the role of OC and soft practices in LM.

2.3. Organizational culture and lean management

Since the 80s a relevant number of studies have been developed to examine the role of OC in determining organization success (Ouchi, 1981, Deal and Kennedy, 1982 and Peters and Waterman, 1982) and have provided empirical evidence on the relationship between OC and performance (Gordon and DiTomaso, 1992, Lee and Yu, 2004, Nikolic et al., 2011 and Prajogo and McDermott, 2011). Among these studies, the vast majority have focused on the fit between OC and specific practices, like quality management, in order to achieve a superior performance (Detert et al., 2000, Nahm et al., 2004, Prajogo and McDermott, 2005, Naor et al., 2008, Patel and Cardon, 2010,Baird et al., 2011 and Narasimhan et al., 2012). The underlying assumption is that since the competitive objectives differ depending on the strategic direction of a firm (Porter, 1985), there isn't a universal OC profile that always guarantees the success (Denison and Mishra, 1995, Fey and Denison, 2003 and Prajogo and McDermott, 2011). In fact, researchers have advocated the existence of different and heterogeneous ideal OC profiles, each working as a driver for a particular management program or improvement initiative (e.g., Detert et al., 2000). In line with these studies, Prajogo and McDermott (2011) showed that some cultural characteristics are associated with certain benefits, but not with others. They demonstrated for example that a hierarchical culture based on control, formalization, stability and predictable outcomes is positively related with process quality improvements but not with innovation, while vice versa a developmental culture characterized by flexibility, growth, innovation and creativity is correlated with innovation but not with quality. There are many examples that show how certain levels of OC dimensions are associated to different and sometimes opposite performance outcomes, confirming the inconsistency of an ideal OC valid for any context and management program. Low assertiveness is typical of those companies that are well coordinated and internally integrated, but these characteristics, which generally can improve a company operational performance, however may also create rigidity and a low responsiveness, thus penalizing companies operating in a dynamic environment (Fey and Denison, 2003). The same authors highlighted that also the role of power distance is not straightforward, as from one side a high power distance hinders employees' empowerment, while from the other side, a low power distance makes it difficult to establish a clear strategic direction. Furthermore, high levels of uncertainty avoidance and institutional collectivism fit with quality improvement objectives since they are associated with conformity, standardization and team working (Prajogo and McDermott, 2011), but the same levels of uncertainty avoidance and institutional collectivism could limit creativity and reduce internal competition among new product development teams, thus negatively impacting on innovation and time-to-market (Peters and Waterman, 1982). Finally, even though it could be argued that effective companies should show high levels of in-group collectivism, future orientation, performance orientation and humane orientation because these could favour employees' virtuous behaviors, literature converges on the assumption that in any case what is really important is their fit (or congruence) with managerial practices able to generate synergistic mechanisms that, in turn, improve operational performance (Lozeau et al., 2002, Ansari et al., 2010 and Kull et al., 2014). Lozeau et al. (2002) showed that when a misfit between OC and practices occurs, the firm may corrupt and distort the practices in order to make them compatible with the values and behaviors of the organization, and these practice corruption decreases the chances of performance improvements. In the same vein, Ansari et al. (2010) argued that the cultural misfit with a practice tends to decrease either the fidelity or the extension of the practice, thus causing inefficient adaptations and superficial adoptions that lead to suboptimal performance results, as confirmed by Kull's et al. (2014) study on the congruence between culture and LM and its impact on operational performance.

Consistently with all this reasoning, the focus of the present study is comparing successful and unsuccessful lean plants to understand what is the optimal OC profile that "best fits" with LM.

Many scholars have attempted to formalize the ideal culture for LM, i.e., an OC consistent with LM practices and principles and conducive to superior performance (Wincel and Kull, 2013).

Since some authors recognized the superior performance achieved by Toyota compared to other lean companies, a leading stream in the literature on the OC–LM link focused on TPS (Spear, 1999, Liker, 2004 and Rother, 2009). Spear (1999) codified "the DNA of TPS" in terms of rules or principles that guide designing, operating, and improving activities and processes at Toyota. Similarly, Liker (2004) described the "Toyota way" according to 14 principles on which Toyota based its OC. Rother (2009) analyzed Toyota's organizational routines, i.e., patterns of thinking and behavior, also called *kata*, concerning how the firm approaches the continuous improvement and coaching individuals, respectively. Although these contributions focused on TPS and did not use a well-established OC model, they provided relevant hints of behaviors and values consistent with LM. For instance, fairness and values promoting collaboration in relationships between workers and suppliers and customers form the basis of Toyota's success, as well as the company's commitment to continuously improving processes.

Another major literature stream examined the OC characteristics that support successfully implementing initiatives related to LM, e.g., time-base manufacturing practices (Nahm et al., 2004 and Narasimhan et al., 2012), HRM (Patel and Cardon, 2010), and TQM (Prajogo and McDermott, 2005, Naor et al., 2008 and Baird et al., 2011). These studies are usually based on cultural models well-known in the OC literature, but analyze only a specific or a narrow sub-group of LM practices. To date, the majority of the contributions and the most advanced results concern the TQM bundle (e.g., Bright and Cooper, 1993, Watson and Korukonda, 1995, Tata and Prasad, 1998, Detert et al., 2000,Prajogo and McDermott, 2005, Naor et al., 2008 and Baird et al., 2011). Some studies explicitly analyzed the role of OC as an antecedent of TQM practices (Naor et al., 2008 and Baird et al., 2011). However, other authors emphasized that the relationship between OC and TQM is not straightforward because they can interact and influence each other recursively. For instance, Prajogo and McDermott (2005) showed that OC is an antecedent of TQM practices but also suggested TQM has an additional recursive impact on culture.

In general, several authors recognized that OC and LM practices interact recursively. As argued by Wincel and Kull (2013), lean culture is likely to evolve as lean tools and techniques are implemented and mastered by an organization. Drawing on Toyota's experience, some scholars strived to define how to develop the ideal OC for lean (Liker, 2004, Rother, 2009 and Shook, 2010). For example, Shook (2010) suggested that firms should start by defining the way people act, giving employees the means by which they can successfully do their job, and providing adequate training; the OC will change as a result. More generally, scholars claimed that implementing lean practices allows people to experience lean and acts as a vehicle for the cultural shift of the whole organization (Mann, 2005 and Wincel and Kull, 2013).

2.3.1. Research hypotheses

Starting from previous contributions dealing with behaviors and values conducive to superior performance in implementing LM, in this section, we discuss how plants with a high level of LM implementation and high or low performance (HLHPs and HLLPs, respectively) are expected to differ for each OC dimension of the GLOBE model. Moreover, we suggest using soft practices is a key factor for successfully implementing LM.

Power distance (PD). Firms with a low PD empower individuals in the organization and tend to promote face-to-face contact and communication between employees at different hierarchical levels (Naor et al., 2010). Vice versa, a high PD is consistent with values supporting high stratifications of power and hierarchical control (Wincel and Kull, 2013). In lean firms, all individuals are expected to contribute to enhancing processes by detecting problems and suggesting improvements (Rother, 2009). In particular, shop floor employees play a relevant role in identifying and eliminating waste, since they directly experience problems affecting production lines (Karlsson and Åhlström, 1996 and Shah and Ward, 2007). Since a lower PD favors employee participation in improvement and decision-making processes, successful lean organizations are usually characterized by a lower PD because they are likely to have a greater ability to identify and eliminate waste, and therefore improve operational performance through LM (Naor et al., 2008). Thus, we posit that:

Hypothesis 1a. HLHPs are characterized by lower PD compared to HLLPs.

Institutional collectivism (IC). High IC encourages teamwork and promotes collaborative relations between individuals (Naor et al., 2010), whereas when IC is low, individual goals and interests prevail over group goals (Wincel and Kull, 2013). Intra-firm and inter-firm collaborative relationships play a crucial role in LM (Rother and Shook, 1998 and Shah and Ward, 2007). Within lean companies, teams form to deeply analyze problems and develop effective solutions (Spear, 1999 and Liker, 2004). In addition, for a lean plant, supplier collaboration is critical to avoid quality and delivery problems in supply (Flynn et al., 1995 and Danese et al., 2012). Managerial beliefs encouraging collective actions such as teamwork and integration are necessary to obtain higher performance when applying, for example, time-based manufacturing practices (Nahm et al., 2004), HRM (Patel and Cardon, 2010), and TQM (Baird et al., 2011). This suggests that successful lean organizations more vigorously promote collaborative values in intra-firm and inter-firm relations (i.e., high IC) rather than leveraging individualist values and adversarial relationships within the firms' supply network. Thus, we posit that:

Hypothesis 1b. HLHPs are characterized by higher IC compared to HLLPs.

In-group collectivism (IG). Employees at companies with higher IG are proud of their organization, express loyalty (Deming, 1986), and privilege long-term relational exchanges; whereas individuals in low IG firms tend to feel independent (Triandis, 1995) and are willing to leave the company if their needs or purposes were better satisfied elsewhere (House et al., 2004). Several arguments suggest that people's loyalty to their organizations and related values such as pride and cohesiveness can lead to more effective LM adoption. Employees typically feel that they can make valuable contributions and are more committed to improvement initiatives (Deming, 1986). However, lower IG can result in higher employee turnover, which makes lean initiatives more difficult to sustain and succeed (Bollbach, 2012). Thus, we posit that:

Hypothesis 1c. HLHPs are characterized by higher IG compared to HLLPs.

Future orientation (FO). Firms with high FO encourage long-range planning and are more likely to invest in new technology as well as in programs to develop manufacturing capabilities before they are needed (Naor et al., 2010). In contrast, low FO is consistent with values supporting initiatives directed at achieving short-term results (House et al., 2004). A company's philosophy promoting long-term thinking sustains a successful LM implementation (Liker, 2004 and Achanga et al., 2006). In fact, Flynn et al. (1994) observed that a culture high in future orientation supports continuous improvement, which in turn enhances the firm's performance. Moreover, Detert et al. (2000) proposed that the ideal OC for firms involved in TQM programs is characterized by a long-term orientation and strategic approach to management, and stressed the importance of these values to obtain successful results. Therefore, we posit that:

Hypothesis 1d. HLHPs are characterized by higher FO compared to HLLPs.

Performance orientation (PO). Firms with high PO favor goal-directed behavior and reward employees who contribute to the company's objectives, whereas low PO firms do not leverage their incentive system to encourage workers to improve performance (Naor et al., 2010). Rother (2009) emphasized Toyota's approach to fixing a concrete objective before launching improvement projects. In this way, the team members' efforts are likely to converge toward a common goal, limiting contrasts and increasing team effectiveness. Similarly, Baird et al. (2011) found that companies that focused on results and had high performance expectations extensively implement TQM and achieve better performance. Lean firms often use incentives to direct employees' behavior toward lean goals (Fullerton and McWatters, 2002). Successful lean plants are expected to have a higher PO because this can favor the alignment of all individuals and team members toward these goals. Therefore, we posit that:

Hypothesis 1e. HLHPs are characterized by a higher PO compared to HLLPs.

Assertiveness (AS). Firms with low AS communicate to seek consensus and solve conflict among individuals from different functions or divisions (Naor et al., 2010), whereas high AS is consistent with individualism and self-initiative (Kluckhohn and Strodtbeck, 1973). Wincel and Kull (2013) claimed that higher AS is likely to result in a less effective LM implementation. In fact, an individualist approach contrasts with LM practices of group problem solving since, especially when people of different functions are involved, it is likely to result in conflict and fewer chances to develop effective solutions. As found by Lee et al. (2013), a low level of coercive influence is a key attribute distinguishing highly effective teams, i.e., teams obtaining superior performance; vice versa, the use of coercive means by certain team members to influence others to accept their views can have a detrimental effect on team morale and performance (Tjosvold, 1986). Therefore, successful lean organizations are expected to be characterized by lower AS, since this generally favors a constructive dialogue among employees and, in particular, among group members when inter-functional teams are created to solve problems. Thus, we posit that:

Hypothesis 1f. HLHPs are characterized by lower AS compared to HLLPs.

Uncertainty avoidance (UA). Organizations with high UA tend to avoid uncertainty by adopting procedures and methods based on facts and objective data to support decisions, whereas low UA favors decision making based on intuition and opinion (Naor et al., 2010). Higher UA fosters LM effectiveness, since it fits practices controlling processes and standardizing work that are important for lean firms to face variations and unpredictable results, and thus are recognized as the basis of an effective lean implementation (Spear and Bowen, 1999 and Liker, 2004). Conversely, lean plants not interested in reducing uncertainty consider these approaches costly, time-consuming, and unnecessary, and thus are more likely to base their decision making and activities on intuition rather than facts and objective data, with detrimental performance results. Thus, we posit that:

Hypothesis 1g. HLHPs are characterized by higher UA compared to HLLPs.

Humane orientation (HO). Firms with high HO are formed by individuals who perceive each other as a valuable resource for their organizations and do not behave opportunistically as in the case of low HO companies (Naor et al., 2010). Consistent with high HO, one TPS rule was not stigmatizing failures, by shifting the focus from the individual to the process when facing problems, based on the assumption that they are caused by poor processes rather than workers (Rother, 2009; Detert et al., 2000). In this type of organizational context, people do their best to make the firm successful, instead of pursuing personal gains. This behavior is fundamental for successfully implementing lean, by supporting practices such as group problem solving, teamwork, and employee suggestions. These arguments suggest that high HO is a fundamental characteristic of successful lean plants that should not punish workers but value their contributions to achieve excellence. Thus, we advance that:

Hypothesis 1h. HLHPs are characterized by higher HO compared to HLLPs.

These hypotheses suggest that successful lean plants usually have a specific OC compared to unsuccessful lean plants. This OC profile is distinctive of successful lean plants because it fits with the peculiarities of the lean practices, thus leading to superior performance. On the contrary, for each deviation (i.e., misfit) from the ideal OC profile, lean plants achieve a worse performance because they corrupt the implementation or limit the extension of those practices which clash with values and behaviors of the organization (Lozeau et al., 2002 and Ansari et al., 2010).

Linked to this, another distinctive characteristic of successful lean plants is the broader use of soft practices compared to unsuccessful lean plants. This is because soft practices are related to principles, managerial concepts, people, and relations, that are more likely influenced by potential deviations from the ideal OC for LM implementation. The corruption or limited extension of soft practices is especially problematic for performance improvements. In particular, as stated in Section 2.2.1, adopting hard tools without adequately implementing soft practices was recognized as the main reason for poor performance in several LM projects (Hines et al., 2004 and Liker and Rother, 2011). For example, Matsui (2007) argued that hard practices, such as JIT, have only a marginal effect on operational performance when soft practices are not fully used. Some leading authors agree that Toyota's success is linked to the way the firm manages people (Spear, 1999, Rother, 2009, Liker and Hoseus, 2010 and Liker and Rother, 2011). Individuals are perceived as the core of TPS and the cornerstone of creating value. For these reasons, Toyota invests in human resources by training employees, growing leaders, and supporting suppliers in continuous improvement (Liker and Hoseus, 2008). The importance of supplier collaboration in an LM environment was also suggested by Hsu et al. (2009) and Romano and Formentini (2012) as without strong supplier assistance, continuous improvement is not supported and hard LM practices cannot be successful. In addition, strong leadership interested in quality, based on top managers actively promoting a vision focused on improving quality and personally involved in quality improvement projects, is widely recognized as fundamental to effectively improve processes (Spear, 1999 and Rother, 2009). Flynn et al. (1995) emphasized that managers' support is vital if a company wants to improve its operational performance through LM because they help to direct LM efforts toward the expected results. Extensive use of teamwork and group problem solving complements these practices, by involving individuals at all levels of the organization and increasing their commitment to improvement initiatives (Spear, 1999 and Rother, 2009). Finally, to be flexible and responsive to the changing conditions of the environment, lean plants should maintain close relationships with their customers, regularly gathering information on their needs and feedback on the firm's performance (Spear, 1999, Rother, 2009 and Liker and Hoseus, 2010).

Consistent with these arguments, numerous empirical studies support that employee training to perform multiple tasks, inter-functional teams, top management leadership for quality, collaborative relationships with customers and suppliers, and a common focus on continuous improvement are all fundamental for implementing LM effectively (Flynn et al., 1995 and Cua et al., 2001; Shah and Ward, 2007). The assumption is using soft practices makes it possible to avoid actors involved in implementing LM resisting change, which is common in LM projects and typically leads to failed LM (Bhasin, 2012). Soft practices help create the appropriate environment for implementing hard LM tools, by educating managers, employees, customers, and suppliers about the importance of changing the production system according to an LM perspective. Thus, we postulate that:

Hypothesis 2. HLHPs differ from HLLPs in terms of greater adoption of soft practices.

3. Methodology

3.1. Data collection and sample

To test the research hypotheses, we used the High Performance Manufacturing (HPM) database. HPM is an international research project that analyzes the relationships between a firm's practices and performance. The HPM sample includes manufacturing plants operating in mechanical, electronics, and transportation equipment sectors (SIC codes: 35, 36, and 37, respectively) located in ten countries, i.e., Austria, China, Finland, Germany, Italy, Japan, South Korea, Spain, Sweden, and the US. In each country, data were collected by local HPM research teams, who were responsible for selecting the plants, contacting them, distributing the questionnaires, and providing assistance to the respondents, to ensure the information gathered was complete and correct. The plants were randomly selected from a master list of manufacturing plants (i.e., using Dun's Industrial Guide, JETRO database, etc.). In each country, the local HPM research team had to include an approximately equal number of high-performing and traditional manufacturing units, to build a sample of plants that use advanced practices in their industry, i.e., world-class manufacturing plants, as well as traditional (i.e., not world-class manufacturing) plants. Finally, all plants had to represent different parent corporations and have at least 100 employees. The plant size was restricted to plants with more than 100 employees to ensure that a sufficient number of managers and employees would be available to complete the survey (Naor et al., 2010). Approximately 65 percent of the plants contacted agreed to administer the survey and filled out the questionnaires. Data from 317 plants were returned. Table 3 reports additional information about the sample distribution for each country and industry.

Table 3. Sample distribution.

	Industry			***Total plants per country***
Country	Electronics	Machinery	Transportation	
Austria	10	7	4	*21*
China	21	16	14	*51*
Finland	14	6	10	*30*
Germany	9	13	19	*41*
Italy	10	10	7	*27*
Japan	10	12	13	*35*
South Korea	10	10	11	*31*
Spain	9	9	10	*28*
Sweden	7	10	7	*24*
United States	9	11	9	*29*
Total plants per industry	*109*	*104*	*104*	*317*

Each plant participating in the HPM project received a batch of 23 questionnaires, distributed by individual visits or by mail to different respondents considered the best informed about the topic of each questionnaire (Table 4).

Table 4. Respondents.

Recipient of the questionnaire	**Number of respondents per plant**
Plant accounting manager	1
Direct labor	10
Human resources manager	1
Information systems manager	1
Production control manager	1
Inventory manager	1
Member of product development team	1
Process engineer	1
Plant manager	1
Quality manager	1
Supervisor	3
Plant superintendent	1
Total respondents per plant	*23*

To reduce the problem of common method bias, whenever possible, the same item was administered to different respondents within the same plant. Then, for plant-level analysis, for each item we aggregated individual informant responses to the plant level by taking the average of the within-plant responses. Each questionnaire consisted of perceptual scales and objective items. In particular, it included a mix of item types and reversed scales to further reduce the possibility of common method variance. The questionnaires were originally developed in English and then were translated into the language of the participating country by a local member of the HPM team. The questionnaire was then back-translated into English by a different local HPM researcher to ensure accurate translation.

3.2. Variables and scales

The present work uses only a portion of the HPM questionnaires. The HPM scales are based on the literature and previously used measurement scales. In addition, at the beginning of the HPM project, the content validity of each scale was checked through interviews with experts and managers. As a result, in this study we adapted scales validated in past works and used extensively in the OM literature.

A measurement of the multidimensional concept of organizational culture is based on and adapted to the eight multi-item scales conceived by Naor et al. (2010), i.e., power distance (PD), institutional collectivism (IC), in-group collectivism (IG), future orientation (FO), performance orientation (PO), assertiveness (AS), uncertainty avoidance (UA), and humane orientation (HO). The items used to measure these scales targeted shop floor employees, supervisors, and human resource managers. Respondents were asked to provide their opinions on different aspects of OC by using Likert scale perceptual items, with values ranging from 1 (i.e., strongly disagree) to 7 (i.e., strongly agree) (seeAppendix A). The number of respondents is not a representative sample of the plant, and this is a limitation when measuring a plant's OC. Thus, we asked the CEOs (or a coordinator within each plant) to identify as respondents key plant informants and people considered the most knowledgeable. In addition, for each item we checked the inter-rater agreement by measuring the interclass correlation (ICC) index. We found that all ICC indexes are greater than 0.70, indicating an acceptable concordance among the different informants (James et al., 1984).

Regarding the LM concept, given its configurational nature, we first identified the LM practices usually included in the literature to characterize LM. Second, in line with previous OM studies, we classified the practices as soft or hard. Table 2 reports well-known and widely cited works on LM, and highlights, for each practice (on the lines), the studies that used that practice to measure LM, as well as those that classified it as a soft or hard practice (see Section 2.2). We considered six multi-item perceptual scales for hard practices – i.e., setup time reduction (ST), JIT deliveries by suppliers (JT), equipment layout for continuous flow (EL), *kanban* (KA), statistical process control (SPC), and autonomous maintenance (TPM) – and six for soft practices—i.e., small group problem solving (SGPS), training employees (TE), top management leadership for quality (TML), supplier partnership (SP), customer involvement (CUST), and continuous improvement (CI). In Appendix A is the complete list of items used to measure each scale and descriptive statistics. All items were evaluated with a seven-point Likert scale (1 is for "strongly disagree" and 7 is for "strongly agree"). Since several different types of respondents were involved, such as quality and human resource managers, and direct labors, we tested the inter-rater agreement validity, as we did for the OC part of the questionnaire.

As well as measuring the adoption of different LM practices through a set of multi-item perceptual scales, the HPM questionnaire also includes a question concerning the overall level of lean manufacturing application in the plant compared to competitors on a five-point Likert scale (1 is for "poor, low" and 5 is for "superior"). We used this variable to distinguish between lean and non-lean plants in the sample (see Section 3.3), according to the definition of lean plant we adopted in this research. This item targeted three types of respondents: quality manager, plant manager, and plant superintendent. The ICC score above 0.70 supports the validity of this measure, and reduced potential biases in classifying a plant as lean. In addition, to further control for this bias, we verified the existence of a significant correlation between this item and all LM practices reported in Table 2. This provides evidence that plants classified as lean in this study do implement LM practices.

Finally, to measure plant performance, we considered four dimensions, i.e., cost, quality, delivery, and flexibility, in terms of perceptual and relative measures of performance (e.g., Cua et al., 2001 and Bozarth et al., 2009). In particular, the respondents were asked to compare their performance with that of competitors on a 5-point Likert scale (from 1 indicating "poor, low" to 5, "superior"), in terms of the unit cost of manufacturing, quality conformance, on-time delivery performance, fast delivery, flexibility in changing the product mix, and flexibility in changing the product volume. We computed an overall measure of plant performance by calculating the mean of these six items and used this value to distinguish between high and low performers in the sample (see Section 3.3). As we noted in Section 1, we did not use objective or subjective measures of performance improvements obtained through LM, because this study included plants that operate in different settings. Thus, comparing performance improvement across plants would be very difficult. Objective or subjective measures of LM success depend on the plant's starting situation and context (i.e., complexity of the products, production strategy, demand variability etc.). In addition, perceptual measures of performance improvements depend on managers' expectations. However, the performance measures adopted in this study also have limitations. First, a superior performance compared to competitors is not necessarily a result of LM. Thus, we controlled for potential confounding effects and endogeneity (see Section 3.3). Second, perceptual measures can be subject to biases. Thus, in line with other studies (e.g., Danese and Kalchschmidt, 2011), we collected objective data of plant performance and verified the existence of a significant correlation between perceptual measures and objective data (standardized by industry). For instance, we found that the unit cost of manufacturing correlated with manufacturing costs (in dollars), on-time delivery with the percentage of orders shipped on time, fast delivery with the average lead time (i.e., days from the receipt of an order until it is shipped), flexibility in changing the product mix and volume with the total cycle time (i.e., days from the receipt of raw materials until the product is received by the customer). After having verified the existence of a significant correlation between perceptual and objective measures of operational performance, we decided to use perceptual scales because are more robust than the objective ones when comparing plants operating in different competitive contexts (e.g., sector, firm size, product complexity etc.).

3.2.1. Measurement scale assessment

We ran an iterative modification process based on confirmatory factor analysis (CFA) using LISREL 8.80 to refine the OC and LM scales and assess the unidimensionality of the constructs under study. In particular, for each construct, we developed a single-factor CFA model and checked that the model parameters fell within the recommended limits. Whenever this condition was not fulfilled, we refined the model by deleting one item at a time, and repeated this procedure until the model parameters were acceptable (Jöreskog and Sörbom, 1989). In the case of constructs made up of fewer than four items, we considered and tested a two-construct model to have sufficient degrees of freedom to compute fit statistics (Li et al., 2005). Then we tested three CFA models. The first model concerned OC and included eight latent variables. The second and third models examined hard and soft LM practices, respectively, and each included six latent variables. Table 5, Table 6 and Table 7 report the CFA results generated from these measurement models. The overall fit of each CFA model was satisfactory. In fact, the relative χ^2 was between 1 and 3, the CFI value was greater than 0.90, the RMSEA was lower than 0.08, and in particular the lower and upper limits of the confidence interval for the RMSEA were lower than 0.05 and 0.08, respectively (Hair et al., 2006). Thus, the overall fit of the measurement models investigated was acceptable. In each CFA model, all standardized estimates of the observed variables exceeded 0.500, and all the corresponding *t*-values were statistically significant (*t*-values statistically significant at $p<0.001$). The significant and substantial item loadings provided statistical evidence of convergent validity. In addition, for each latent variable, we checked that the composite reliability was greater than 0.7, indicating high reliability. Finally, to assess discriminant validity, we performed a series of delta χ^2 tests. Specifically, for each possible pair of latent variables, we compared two nested models: (1) the model with free correlation between the two constructs and (2) the nested model with the correlation set to 1. In accordance with the method used by Huang et al. (2008), if the delta χ^2 was statistically significant, the two latent variables were distinct. Discriminant validity was confirmed for our constructs since all the χ^2 differences were statistically significant ($p<0.001$; detailed results available upon request).

Table 5. CFA results for organizational culture.

Construct	Item[a]	Factor loading	*t*-Value
Power distance	PD1	0.647	–
	PD2	0.553	8.027
	PD3	0.655	9.155
	PD4	0.570	7.648
Institutional collectivism	IC1	0.661	–
	IC2	0.615	9.152
	IC3	0.500	7.211
	IC4	0.522	7.473
	IC5	0.549	8.307
In-group collectivism	IG1	0.861	–
	IG2	0.889	20.873
	IG3	0.864	19.927
	IG4	0.817	18.117
Future orientation	FO1	0.646	–
	FO2	0.825	11.681
	FO3	0.620	9.414
	FO4	0.838	11.779
Performance orientation	PO1	0.843	–
	PO2	0.943	19.340
	PO3	0.754	15.568
Assertiveness	AS1	0.599	–
	AS2	0.758	10.128
	AS3	0.773	10.247
	AS4	0.768	10.204
Uncertainty avoidance	UA1	0.522	–
	UA2	0.549	4.392
	UA3	0.889	4.496
Humane orientation	HO1	0.500	–
	HO2	0.800	6.353
	HO3	0.501	5.490
	HO4	0.712	6.258

χ^2=862.238 (406); RMSEA=0.0619 [0.0565; 0.0674] CFI=0.90.

[a] In order to control for industry effects, we standardized the individual items by industry.

Table 6. CFA results for hard-lean practices.

Construct	**Item**[a]	**Factor loading**	***t*-Value**
Equipment layout	EL1	0.722	–
	EL2	0.811	12.973
	EL3	0.770	12.443
	EL4	0.642	10.489
Just in time delivery by suppliers	JT1	0.711	–
	JT2	0.570	8.978
	JT3	0.658	10.233
	JT4	0.536	8.478
	JT5	0.566	8.925
Kanban	KA1	0.682	–
	KA2	0.851	12.669
	KA3	0.858	12.669
Setup time reduction	ST1	0.673	–
	ST2	0.655	9.857
	ST3	0.676	10.108
	ST4	0.568	8.712
Statistical Process control	SPC1	0.848	–
	SPC2	0.881	20.003
	SPC3	0.655	12.875
	SPC4	0.915	21.009
Autonomous maintenance	TPM1	0.699	–
	TPM2	0.544	8.311
	TPM3	0.686	10.122
	TPM4	0.732	10.595

$\chi 2$=973.782 (436); RMSEA=0.0655 [0.0604; 0.0707] CFI=0.91.

[a] In order to control for industry effects, we standardized the individual items by industry.

Table 7. CFA results for soft-lean practices.

Construct	Item[a]	Factor loading	*t*-Value
Top management leadership for quality	TML1	0.664	–
	TML2	0.825	12.336
	TML3	0.642	10.052
	TML4	0.811	12.184
	TML5	0.745	11.397
Supplier partnership	SP1	0.720	–
	SP2	0.470	7.280
	SP3	0.760	10.77
	SP4	0.596	9.049
Small group problem solving	SGPS1	0.613	–
	SPGS2	0.813	11.366
	SPGS3	0.813	11.367
	SPGS4	0.835	11.565
	SGPS5	0.613	9.243
	SPGS6	0.699	10.219
Continuous Improvement	CI1	0.737	–
	CI2	0.462	7.733
	CI3	0.713	12.006
	CI4	0.591	9.932
	CI5	0.726	12.240
Training employees	TE1	0.758	–
	TE2	0.863	14.895
	TE3	0.456	7.737
	TE4	0.786	13.746
	TE5	0.622	10.724
Customer involvement	CUST1	0.692	–
	CUST2	0.678	10.496
	CUST3	0.757	11.492
	CUST4	0.669	10.373

χ^2=1135.974 (506); RMSEA=0.0664 [0.0617; 0.0713] CFI=0.90.

[a] In order to control for industry effects, we standardized the individual items by industry.

3.3. Forming a priori groups

To perform the multi-group analysis (Sorbom, 1974), we formed four a priori groups. First, we split our sample into lean vs. non-lean adopters, by using the question about the level of LM applied in the plant (see Section 3.2). After computing the statistical median score of this single-item scale (equal to 3.3 on a 5-point Likert scale), we assigned a high lean (HL) or low lean (LL) implementation value to the plants with a score above or below the median, respectively. Second, we followed the same procedure to assign a high-performer (HP) and low-performer (LP) score to the plants in our sample, where an HP value refers to the plants with a performance score above the median (equal to 3.67 on a 5-point Likert scale), while an LP value refers to plants with a performance score below the median. Finally, by crossing the lean adoption and performance dummy variables, we formed four groups of plants, as shown in Table 8. This study focused on plants characterized by a high level of LM implementation and high performance (HLHP) and plants with a high level of LM implementation and low performance (HLLP).

Table 8. Number of plants for the a-priori groups.

GROUP	Lean implementation score	Performance score	No. of plants
HLHP (High lean implementers and high performers)	HL (high)	HP (high)	95
HLLP (High lean implementers and low performers)	HL (high)	LP (low)	63
LLHP (Low lean implementers and high performers)	LL (low)	HP (high)	63
LLLP (Low lean implementers and low performers)	LL (low)	LP (low)	96

To avoid endogeneity and potential biases that may affect the results of our analyses and ensure that the success of lean plants is due to LM (i.e., not due to other factors), we preliminarily controlled for the effect of relevant variables.

First, since our database includes plants in multiple countries, we checked for the influence of NC. In accordance with Naor et al. (2010), we divided our sample between Western and Eastern plants and looked for differences in OC dimensions. Similarly to the results of Naor et al. (2010), we found that the two regions differ in terms of IG, FO and PO. This suggests that there could be an interplay between NC and OC. Therefore, we checked also for differences in terms of OC and soft practices between Western and Eastern successful lean plants (i.e., Western HLHPs vs. Eastern HLHPs), in order to control whether a specific OC profile or a different use of soft LM practices characterized successful lean plants across regions. We found no significant differences among these two groups. This result, on the one hand, suggests that the NC does not affect the OC profile and soft practices of successful lean plants, and on the other hand provides some interesting suggestions for future research. In fact it could be interesting to investigate whether and to what extent the differences in OC found between the two regions could play a role in facilitating or contrasting the early phases of LM adoption (Section 4.1).
We also checked for differences between HLHPs and HLLPs in terms of imports, exports, and plant size. The level of a plant's performance could be influenced by the plant's level of internationalization and resources available. We used the percentage of purchases from outside the home country to measure imports, the percentage of sales to customers outside the home country to measure exports, and the log of the total number of employees to measure the plant size. We found that none of these variables was significantly different across the two groups.

In addition, we considered the product life cycle to verify whether market dynamism could predict differences between HLHP and HLLP plants. We used the log of the average product life cycle (in years). Again, we did not find a difference among the two groups. Finally, we controlled for the effect of a plant's position along the supply chain, as the position can influence performance as well as results achieved through LM. To measure the supply chain position, we used McKone-Sweet and Lee's (2009) scale, which measures a plant's percentage of sales for each type of customer (i.e., end consumers, retailers, wholesalers, distributors, assemblers, and manufacturers) and calculates a weighted average by assigning a weight to each type of customer from 1 (end consumers) to 6 (manufacturers). Again, we found that HLHPs and HLLPs did not differ significantly.
These results reduce the risk that the successful results achieved by HLHP plants depend on confounding factors reflected in the control variables.

3.4. Multi-group analysis

To investigate the research hypotheses, we used the multi-group analysis method and LISREL 8.80 (Sorbom, 1974). The aim was to test for differences between successful and unsuccessful LM plants in terms of OC dimensions and application of LM practices. Numerous researchers have attested to the advantages of Sorbom's (1974) method compared to the traditional general linear models (e.g., Lubke et al., 2003 and Raykov, 2001). These advantages are linked to the possibility of estimating the parameters for all groups simultaneously. Thus, this approach helps compare different theoretical models to determine the one that best fits the data. Furthermore, this approach evaluates latent mean differences, by considering measurement error variance, and thus obtaining more precise and accurate results compared to other methods such as the *t*-test or ANOVA (Martınez-Costa et al., 2009).
The measurement invariance assessment between groups represents the first step for testing group-mean differences. This assessment ensures that the constructs in the groups are equivalent, namely, that the mean differences between groups are not affected by different patterns between latent and observed variables (Lubke et al., 2003). Scholars

(e.g., Koufteros and Marcoulides, 2006 and Ployhart and Oswald, 2004) have suggested that invariance tests should proceed according to four steps (or levels): configural, metric, scalar, and factorial invariance. Configural invariance tests whether the same number of factors and factor-loading pattern hold across groups; metric invariance tests whether the indicators have the same causal relationships with their respective constructs across groups (i.e., the factor loadings are identical); scalar invariance tests the invariance of intercept terms to determine consistency between differences in latent means and observed means; and factorial invariance compares measurement error variances and covariances between groups. In accordance with several previous studies (e.g., Meredith, 1993 and Byrne, 1998), we decided not to investigate factorial invariance, as it usually is excessively restrictive and is the least important. To determine evidence of invariance, we ran an iterative process that assessed the absence of significant differences in χ^2 values (delta χ^2) between each pair of nested models. We developed the process from a baseline model by forcing increasingly stringent constraints on the parameters (Byrne, 1998). Since we did not detect significant differences in our measurement models, we ensured that the groups are configural, metric, and scalar invariant. Thus, we could compare the relevant latent variable means of the HLHP and HLLP groups by performing delta χ^2 tests.

3.5. Multi-group analysis results

To test Hypothesis 1a, Hypothesis 1b, Hypothesis 1c, Hypothesis 1d, Hypothesis 1e,Hypothesis 1f, Hypothesis 1g and Hypothesis 1h, we ran a multi-group analysis that included each OC dimension. Table 9 reports the latent variable means for the groups and the differences in χ^2 values (delta χ^2) between the HLHPs and HLLPs. The results of the analysis indicate that, among the eight OC dimensions, IC, FO, AS, and HO are significantly different between the HLHP and HLLP groups, providing support for Hypothesis 1b, Hypothesis 1d, Hypothesis 1f and Hypothesis 1h. No significant differences between the two groups were found for the PD, IG, PO, and UA dimensions. In addition, we ran an additional multi-group analysis that included hard and soft lean practices (Table 10). Results indicate that HLHP and HLLP plants failed to show significant differences for any of the hard dimensions considered—i.e., TPM, KA, EL, SPC, JT, and ST. Instead, the two groups significantly differed in the adoption of almost all soft lean practices (except for TML)—CI, TE, SGPS, SR, and CUST, providing support for Hypothesis 2.

Table 9. Multi-group analysis results for OC dimensions.

OC dimension		HLHP	HLLP	Deltaχ^2
PD	Power distance	−0.167	0.011	1.724
IC	Institutional collectivism	0.275	−0.057	4.156*
IG	In-group collectivism	0.309	0.018	3.107
FO	Future orientation	0.245	−0.231	8.623*
PO	Performance orientation	0.154	0.011	2.859
AS	Assertiveness	−0.228	0.040	4.011*
UA	Uncertainty avoidance	0.026	−0.070	1.698
HO	Humane orientation	0.118	−0.028	3.931*

Table 10. Multi-group analysis results for LM dimensions.

LM dimension		HLHP	HLLP	Deltaχ^2
CI	Continuous improvement	0.363	−0.022	4.193*
TE	Training employees	0.391	−0.013	7.342*
TML	Top management leadership for quality	0.285	−0.048	2.142
SGPS	Small group problem solving	0.291	−0.099	4.236*
SP	Supplier partnership	0.299	−0.055	3.964*
CUST	Customer involvement	0.289	−0.139	4.008*
TPM	Autonomous maintenance	0.265	−0.001	1.523
KA	Kanban	0.312	0.099	2.874
EL	Equipment layout	0.242	0.066	2.002
SPC	Statistical Process control	0.247	−0.024	2.132
JT	JIT deliveries by suppliers	0.281	−0.060	2.447
ST	Set up time reduction	0.285	−0.064	2.692

3.5.1. Additional analyses

To provide a more comprehensive view of the phenomenon, we performed additional tests to better comprehend the role OC and hard and soft practices in LM. First, we compared HL and LL plants in terms of OC dimensions and LM practices implemented. Although these analyses provided data that are beyond the aim of this study (i.e., comparing HLHP and HLLP plants), the outcomes are useful for interpreting the results found for the differences between HLHPs and HLLPs, and provide several directions for future research (see Section 4).

As regards OC, the multi-group analyses comparing HLs and LLs revealed significant differences between these groups in three dimensions: IG, FO, and UA (Table 11). Interestingly, although IG and UA were significantly different in HL and LL plants, these dimensions are not significantly different in HLHP and HLLP plants. This suggests that IG and UA may favor the implementation of LM, and thus assume different values in lean and non-lean adopters.

Table 11. Multi-group analysis results for OC dimensions (results obtained after testing invariance).

OC dimension		HL	LL	Deltaχ^2
PD	Power distance	−0.166	0.167	3.291
IC	Institutional collectivism	0.174	−0.106	3.393
IG	In-group collectivism	0.172	−0.170	5.216*
FO	Future orientation	0.126	−0.102	6.447*
PO	Performance orientation	0.087	−0.086	3.083
AS	Assertiveness	−0.115	0.115	2.280
UA	Uncertainty avoidance	0.117	−0.094	4.363*
HO	Humane orientation	0.090	−0.085	1.952

Again, we obtained further details by running an additional multi-group analysis comparing HLs and LLs in terms of hard and soft practices. In general, it can be expected that lean plants extensively implement all lean practices reported in Table 2. Nevertheless, as pointed out in Section 1, managers' perceptions of what implementing LM means sometimes differ. Analyzing the differences between LLs and HLs can help us to examine whether lean plants in general give equal importance to hard and soft practices. The outcomes revealed significant differences for all the hard dimensions considered, but not for the soft dimensions (Table 12). This means that in several cases, managers who were asked to evaluate the overall level of LM application in the plant compared to competitors considered the level "high" because hard practices had been implemented. By simultaneously considering the result that HLHPs differed for soft practices adoption (Table 10), we can conclude that what really makes the difference in successfully implementing LM is adopting soft, rather than hard, practices.

Table 12. Multi-group analysis results for LM dimensions (results obtained after testing invariance).

LM dimension		HL	LL	Deltaχ^2
CI	Continuous improvement	0.151	−0.148	3.573
TE	Training employees	0.138	−0.155	3.145
TML	Top management leadership for quality	0.115	−0.109	2.901
SGPS	Small group problem solving	0.122	−0.098	2.988
SP	Supplier partnership	0.065	−0.041	2.134
CUST	Customer involvement	0.141	−0.135	3.214
TPM	Autonomous maintenance	0.160	−0.159	5.887*
KA	Kanban	0.165	−0.181	4.592*
EL	Equipment layout	0.187	−0.186	5.803*
SPC	Process control	0.165	−0.161	5.519*
JT	JIT deliveries by suppliers	0.166	−0.167	7.797*
ST	Set up time reduction	0.126	−0.114	7.604*

Finally, we analyzed the OC differences between LLHP and LLLP plants to understand whether they differed for a set of OC variables, which is diverse from the set distinguishing HLHP plants. Results of the multi-group analysis showed that LLHPs had a lower PD and higher IC, IG, FO, PO, and HO compared to LLLPs (Table 13). Taken together, Table 13 and Table 9 highlight some interesting results. First, AS is the only OC dimension that differentiates successful lean plants. In addition, some OC dimensions, such as IC, FO and HO, seem common distinguishing features for high performers; whereas IG, PD and PO are distinguishing features for LLHPs, but they are not for HLHPs.

Table 13. Multi-group analysis results for OC dimensions (results obtained after testing invariance).

OC dimension		LLHP	LLLP	Deltaχ^2
PD	Power distance	−0.085	0.184	4.821*
IC	Institutional collectivism	0.122	−0.325	8.025*
IG	In-group collectivism	0.063	−0.342	4.356*
FO	Future orientation	0.204	−0.225	7.642*
PO	Performance orientation	0.132	−0.245	6.339*
AS	Assertiveness	−0.022	0.177	2.414
UA	Uncertainty avoidance	0.059	−0.121	2.894
HO	Humane orientation	0.089	−0.151	4.045*

4. Discussion

Our study advances the previous literature on OC and lean in different ways. First, it analyzes in detail the OC profile of successful lean plants. Several past contributions provided interesting guidelines for and hints on the role of OC in LM (e.g., Spear, 1999,Liker, 2004, Naor et al., 2008, Rother, 2009, Baird et al., 2011 and Narasimhan et al., 2012). Differently from these works, the present research provides a more comprehensive understanding of the phenomenon. On the one hand, our study relies on a well-established OC model, i.e., the GLOBE model (House et al., 2004), which includes several OC dimensions. On the other hand, while several previous contributions focused on subsets of LM practices (Nahm et al., 2004, Prajogo and McDermott, 2005, Naor et al., 2008, Patel and Cardon, 2010, Baird et al., 2011 and Narasimhan et al., 2012), we considered various lean dimensions and bundles, thus embracing a systemic view of LM. In addition, compared to studies that analyzed OC as an antecedent of LM (Naor et al., 2008 and Baird et al., 2011), the present work is based on a method (i.e., the multi-group analyses) that is more appropriate for studying a complicated phenomenon such as the interplay between OC and LM (Flynn et al., 2010).

This research contributes to existing literature not only by investigating which OC characteristics distinguish successful lean plants but also by providing empirical evidence of the differences between lean and not-lean adopters. These analyses help to better interpret the OC characteristics of successful lean plants. When we compared the OC profiles of HLHP and HLLP plants, we found that the successful lean plants were characterized by higher IC, FO, and HO and lower AS. As hypothesized, high IC promotes intra- and inter-firm collaborations (Rother and Shook, 1998 and Shah and Ward, 2007), FO is the basis for continuous improvement (Flynn et al., 1994, Liker, 2004 and Achanga et al., 2006), and high HO and low AS are important elements in an organization that leverages its employees to improve processes (Rother, 2009; Wincel and Kull, 2013). These are specific characteristics of successful lean plants when compared to the unsuccessful ones, as we expected. However, this does not mean that other OC dimensions are not important for LM. In fact, when we compared lean and non-lean adopters (i.e., HLs and LLs) – besides FO – IG, and UA were also significantly different. A possible explanation is that some OC dimensions favor the lean transformation but alone do not guarantee its success. Instead others can make the difference between high- and low-performing lean plants. Starting from this evidence, future research could further investigate the precise role of each OC dimension in implementing LM. In particular, a longitudinal perspective could help to interpret the dynamics of the interplay between OC and LM.

Further interesting implications can be derived by comparing Table 9 and Table 13, which highlight the OC dimensions that differentiate high-performer lean plants and high-performer non-lean plants, respectively. This comparison makes it evident that some OC dimensions (i.e., IC, FO and HO) are common distinguishing features. This finding suggests that further research is needed in order to understand their role for LM success, because we cannot conclude that these dimensions are exclusive OC characteristics of successful lean plants, given that they are OC traits common to high performers, regardless if they are lean or not. As argued before (Section 2.3), a vast majority of studies converge on the assumption that there isn't a universal OC profile that always guarantees the success. For this reason, we think that this result could enliven the debate and suggest interesting future research directions. In particular, future studies could better investigate the precise effect that these cultural dimensions have on performance as well as their synergistic effect with lean practices. In fact, this study divides high performers into two groups (high vs low performers) and investigates differences in terms of OC, whereas future studies could evaluate the impact of OC, lean practices and their synergy on performance, by considering it as a continuous variable. In particular, we think that the role of IC deserves particular attention, because some relevant studies do not support that IC has in general a positive impact in every context (Peters and Waterman, 1982, Fey and Denison, 2003 and Prajogo and McDermott, 2011).

The comparison of Table 9 and Table 13 shows that the only OC dimension that exclusively differentiates successful lean plants is assertiveness. Low assertiveness permits to optimize coordination and integration of different functions in order to solve potential conflicts between individuals from different divisions (Naor et al., 2010), and allows to synchronize production processes by eliminating barriers across functions as LM requires (e.g., Shah and Ward, 2007). On the contrary, an assertive and individualistic approach in a lean company would lead to the corruption of lean practices, by increasing the difficulty of managing cross-functional teams, cellular production, synchronized value streams etc. However, a high assertiveness could lead to plant success in other contexts. Just to cite a few examples, in contexts where creativity is strategic, competition among functions can help the divergent phase of brainstorming on new product development; in dynamics contexts where responsiveness to customers' requests is a priority, a low assertiveness could decrease plant reactivity; in digitized companies, the competitive advantage may come from the excellence of the sole IT function.

Finally, Table 9 and Table 13 comparison highlights that while IG, PD and PO are distinguishing features for high performance non-lean plants, they are not for successful lean plants. A potential interpretation, which deserves further research, lies in the so-called "replacement effect", which implies that lean practices may replace cultural bases for high performance (Peters and Waterman, 1982). For example, a low IG could lead to high levels of personnel turnover due to low loyalty to their organization. A high turnover is a huge problem for those companies where workers are highly specialized, because they are very difficult to be replaced, and the cost and time for training a new employee are significant. The problem of a low IG in lean companies could be reduced because standard works and visual management lessen the complexity of the tasks and allow to easily transfer knowledge. Furthermore, employees are trained for multi-tasking, thus decreasing inefficiencies due to sudden absences and high turnover. Further examples of the replacement effect concern PD. In non-lean companies the report of problems to managers, and in general communication with managers, are hampered by high levels of PD, whereas in lean plants this effect is mitigated by practices that replace the need of face-to-face communication every time a problem happens. In fact, tools like visual management, *andon*, statistical process control, and kanban cards facilitate continuously transferring feedbacks to managers. A similar effect happens as regards PO. PO can be crucial for non-lean companies because it allows to direct employees toward performance improvements through incentive systems. On the contrary, in lean companies, a high PO could be replaced by the presence of mechanisms, such as takt time, production synchronization, kanban and standard works, that "automatically" drive workers towards performance improvements, even in absence of incentive systems. Even though the replacement effect can provide a useful interpretation of results in Table 9 and Table 13, it is important to note that further research is needed. In fact, in the lean literature (see Section 2.3.1), several arguments support the existence of synergies between lean and a high IG, a low PD and a high PO.

Another contribution of this study concerns the role of soft practices in successfully implementing lean management. As discussed in Section 1, although soft practices are recognized in the LM literature as an essential part of lean (Shah and Ward, 2007), LM projects often result in hard practices without sufficient attention paid to soft practices (Liker, 2004 and Liker and Rother, 2011). Our results show that hard practices do not differentiate successful lean plants; instead, they are different if we consider the adoption of soft practices (Hypothesis 2 held). As hypothesized, successful lean plants devote more attention to employee training, leverage small group problem solving more, maintain more cooperative relationships with suppliers and customers, and promote a continuous improvement philosophy. Comparing lean vs. non-lean plants revealed that lean plants implemented hard practices extensively, even though they do not differ due to soft practices. Thus, even though hard practices remained insufficient per se, we are not saying they are not important, because they are necessary to be lean. However, what really differentiates successful lean plants is greater use of soft practices.

The extensive use of hard practices and, by contrast, the lack of attention to soft practices can be the result of some behaviours and attitudes, which are frequent in those companies which intend to implement lean, but have not fully understood what this exactly means. For instance, Ansari et al. (2010) suggested that an organization sometimes imitates others to conform with its context or in response to social pressures. Imitation per se is not negative, but this desire of conformity can often result in an inefficient adoption or a superficial and incomplete use of practices. In the case of LM, for example, some companies adopt tools that are clearly "visible" – i.e., hard practices, such as kanban, cellular layout, etc. – while neglecting the importance of soft practices, which are intangible and apparently don't modify the facade of the company. Similarly, it can also happen that companies are pressured by customers to adopt LM because they want to receive JIT deliveries by their suppliers (Danese et al., 2012). In this case, suppliers often try to quickly introduce the lean tools necessary to synchronize their production systems with customers demand, but overlook the soft practices because are perceived as something else (e.g., human resource practices) not fundamental to comply with customer requirements, or even worse, because suppliers have a misfitting OC that hinders and corrupts soft practice adoption (Lozeau et al., 2002).

The result that soft practices are fundamental for becoming a successful lean plant has important implications for theory. First, this confirms previous findings stressing the importance of adopting soft practices for a competitive advantage over competitors (Shah and Ward, 2003, Liker, 2004, Lagrosen and Lagrosen, 2005, Matsui, 2007, Shah and Ward, 2007, Fotopoulos and Psomas, 2009 and Liker and Rother, 2011). Second, the differences in soft practices adoption and OC dimensions suggest that successful lean plants have a specific OC profile and implement soft practices more extensively. This result represents an interesting opportunity for future research to better understand the dynamics of a successful lean implementation. In fact, even though the multi-group analyses provided in this study do not offer evidence for how OC and soft practices interact (thus influencing LM success), they could be used as a starting point for future studies, based on a longitudinal perspective, to better explain how OC and soft practices support each other and mutually contribute to a successful LM implementation.

The results provided in the present research are also important for managers, because they explain why hard LM practices are not always the panacea for all manufacturing problems. Managers should bear in mind that successful lean plants do not differ in use of hard practices (e.g., *kanban*), since these practices are order qualifier activities, i.e., essential but not differentiating. Instead, soft practices and certain OC characteristics are strategic "order winner" factors that make the difference in LM implementation. Thus, managers who experience difficulty obtaining performance improvements through LM should wonder whether they have dedicated adequate attention to soft practices and whether their plant's OC is consistent with that characterizing successful lean plants. This research suggests that, when lean companies experience difficulties, they should not invest more resources to increase the level of hard practice implementation; instead, the companies should accurately analyze their context in terms of OC and invest effort in soft practices.

As several practical examples show, managers often judge the overall level of lean implementation in their plant based on the level of the adopted hard practices (Liker, 2004 and Liker and Rother, 2011). Our research supports that this pitfall is common. In fact, in the present study, once we had classified lean plants based on managers' perception of the level of lean application in their plant, we analyzed the differences between the lean and non-lean plants in terms of hard and soft practices. We found that lean plants differed only in hard practices, confirming that several managers wrongly perceive LM primarily as a set of hard practices to be implemented. This empirical evidence advices managers to strive to fully understand what implementing lean means, by suggesting they go beyond the technicalities and experience the potential of soft practices.

4.1. Limitations and future research

Limitations should be considered along with our results. First, the research setting could limit the generalizability of our findings since the HPM sample includes three manufacturing sectors (i.e., machinery, electronics, and transportation components). A replication of the study in different industries could present an opportunity for future research. For example, it might be interesting to understand whether OC dimensions have the same importance in other contexts. In fact, in this study, several OC dimensions (PD and PO) were not significantly different between lean and non-lean adopters or successful and unsuccessful lean plants. Does this mean that these two dimensions do not represent a necessary condition for LM implementation and/or effectiveness? Are they related to LM in other industries?

A second limitation is linked to the cross-sectional nature of the data. This research focuses on investigating the characteristics of successful lean plants in terms of OC and soft practices. Future studies based on longitudinal data could complement this analysis by examining how OC can evolve and interact with soft practices in a lean journey.

Another important limitation of this research is the use of subjective measures of performance. In line with previous studies (e.g., Cua et al., 2001 and Bozarth et al., 2009), as discussed in Section 3.2, we decided to use perceptual and relative measures of performance compared to competitors. Although our choice has some advantages especially when measuring performance of plants operating in different contexts, however it can cause some biases. Thus, further longitudinal studies could corroborate the results found, by analyzing how quantitative measures of a firm's operational performance change over time when applying lean practices.
A further limitation is linked to the number of individuals who completed survey items concerning OC. Future studies could extend the investigation to consider more plant individuals in the sample. In particular, longitudinal analyses involving a limited number of plants and including responses provided by a representative sample of employees could be useful for examining how the OC may change during a lean transformation.

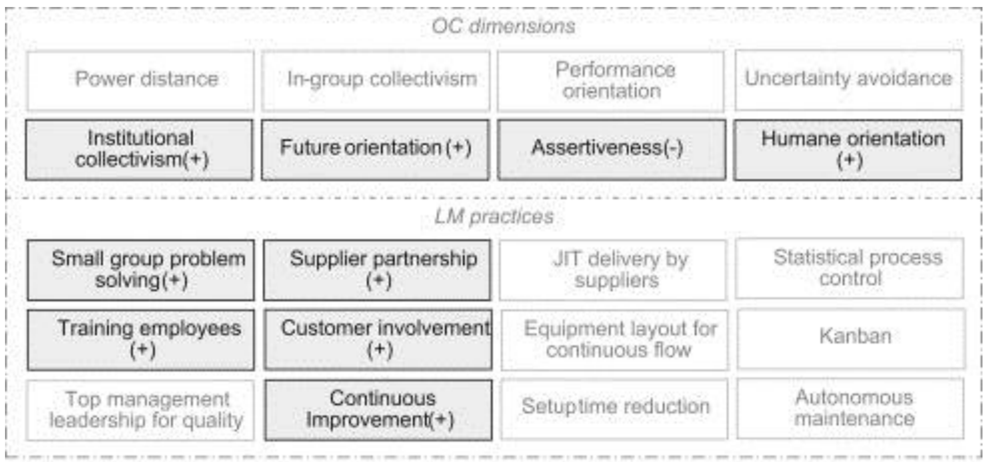
A further opportunity for future research concerns the role of NC in LM. A relevant stream in the operations management literature has debated the interplay between NC and OC, for example, providing different arguments on the applicability of managerial practices worldwide (Naor et al., 2010). This study focused on OC, even though we considered NC to control for potential confounding factors (Section 3.3). Although it is widely accepted that LM can be successfully applied in different countries and there are many practical examples supporting this view (Schroeder and Flynn, 2001, Evans and Lindsay, 2005 and Shook, 2010), previous contributions also demonstrate the importance of NC when implementing LM (e.g., Hofer et al., 2011). Our control analyses on the role of NC in LM provide some results, which suggest interesting directions for future research. We found that in general Western and Eastern plants differ in terms of IG, FO and PO, while successful Western and Eastern lean plants show similar OC profiles and levels of soft practices implemented. Thus, it seems that NC does not influence the OC or soft practices of successful lean plants but, given the interplay between NC and OC, it could be interesting to analyze whether NC can play a role in the early phases of lean adoption by facilitating or contrasting LM. Thus, future multiple-case based studies could investigate in detail whether and how the implementation of each lean practice varies in different countries, and how NC can influence the early phases of lean adoption.

5. Conclusion

The success achieved primarily by Toyota and then by several lean organizations worldwide has led many companies to start a lean project to eliminate waste and significantly improve performance. However, several lean journeys concluded without realizing these expected results (Liker and Rother, 2011). Although over the years scholars have suggested several different causes for LM failures, an inadequate OC and the absence of lean soft practices are

certainly among the most critical and widest acknowledged in the lean literature (e.g., Spear, 1999, Liker, 2004, Rother, 2009 and Liker and Rother, 2011).
Using the GLOBE model of OC (House et al., 2004) and a comprehensive set of LM practices, we analyzed whether successful lean plants are characterized by a specific OC and extensively adopt soft practices. Fig. 1 summarizes the distinctive characteristics (in grey) of successful lean plants in terms of OC and soft practices, compared to unsuccessful lean plants, i.e., higher IC, FO, and HO and lower AS, as well as more widely implemented soft practices, i.e., employee training, small group problem solving, customer involvement, supplier partnership, and continuous improvement. It should be noted that, among IC, FO, HO and AS, only low assertiveness is a exclusive distinctive characteristic of successful lean plants, while a high IC, FO and HO are traits common to non-lean high performers, and thus further research is required to provide conclusive evidence about their role in LM success.

Fig. 1. Distinctive characteristics of successful lean plants (highlighted in grey). Legend: The symbols (+) and (−) mean higher and lower levels compared to unsuccessful lean plants.



Legend: The symbols (+) and (-) mean higher and lower levels compared to unsuccessful lean plants.

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Appendix A.

Organizational culture

Please indicate to what extent you agree/disagree with the following—(circle one number): 1—strongly disagree, 2—disagree, 3—slightly disagree, 4—neutral, 5—slightly agree, 6—agree, and 7—strongly agree.

[a] Reverse code

Power distance		(Mean, S.D.)
PD1	Managers in this plant believe in using a lot of face-to-face contact with shop floor employees[a]	(5.49, 0.76)
PD2	This plant is a good place for a person who likes to make his own decisions[a]	(3.73, 0.80)
PD3	My suggestions are never taken seriously around here	(5.51, 0.73)
PD4	Our organization structure is relatively flat[a]	(4.59, 1.04)
Institutional collectivism		(Mean, S.D.)
IC1	Generally speaking, everyone in the plant works well together	(5.49, 0.75)
IC2	Our supervisors encourage the people who work for them to work as a team	(5.44, 0.72)
IC3	We work as a partner with our suppliers, rather than having an adversarial relationship	(5.69, 0.68)
IC4	We believe that cooperative relationships will lead to better performance than adversarial relationships	(5.84, 0.58)
IC5	We believe than an organization should work as a partner with its surrounding community	(5.73, 0.61)
In-group collectivism		(Mean, S.D.)
IG1	I talk up this organization to my friends as a great organization to work for	(5.26, 0.78)
IG2	I am proud to tell others that I am part of this organization	(5.46, 0.66)
IG3	I am extremely glad that I chose this organization to work for, over others I was considering at the time I joined	(5.31, 0.69)
IG4	For me, this is the best of all organizations for which to work	(4.86, 0.71)
Future orientation		(Mean, S.D.)
FO1	We pursue long-range programs, in order to acquire manufacturing capabilities in advance of our needs	(4.87, 1.05)
FO2	We make an effort to anticipate the potential of new manufacturing practices and technologies	(5.49, 0.80)
FO3	Our plant stays on the leading edge of new technology in our industry	(5.09, 1.01)
FO4	We are constantly thinking of the next generation of manufacturing technology	(5.21, 0.93)
Performance orientation		(Mean, S.D.)
PO1	Our incentive system encourages us to vigorously pursue plant objectives	(4.47, 1.15)
PO2	The incentive system at this plant is fair at rewarding people who accomplish plant objectives	(4.45, 1.11)
PO3	Our reward system really recognizes the people who contribute the most to our plant	(4.22, 1.09)
Assertiveness		(Mean, S.D.)
AS1	Our business strategy is implemented without conflicts between functions[a]	(4.66, 0.95)
AS2	The functions in our plant cooperate to solve conflicts between them, when they arise[a]	(5.53, 0.68)
AS3	Our managers do a good job of solving inter-functional conflicts[a]	(5.19, 0.81)
AS4	Our managers communicate effectively with managers in other functions[a]	(5.35, 0.77)
Uncertainty avoidance		(Mean, S.D.)
UA1	I believe that the scientific method provides a better input to decision making than intuition or opinion	(5.57, 0.88)
UA2	In my view, organizations should use objective data as the basis for making decisions	(5.86, 0.75)
UA3	In this organization, management is based on facts, not on intuition or tradition	(5.39, 0.91)
		(continued)

Humane orientation		(Mean, S.D.)
HO1	I believe that our employees are good people	(4.81, 1.11)
HO2	In my view, most employees are more concerned with personal gain than with helping our organization accomplish its goals[a]	(5.84, 0.60)
HO3	Although there may be a few "bad apples," most of our employees try to help our organization achieve its goals	(4.15, 1.01)
HO4	Some of our employees are probably only out to get what they can from this organization[a]	(5.32, 0.87)

Hard-lean practices

Please indicate to what extent you agree/disagree with the following—(circle one number): 1—strongly disagree, 2—disagree, 3—slightly disagree, 4—neutral, 5—slightly agree, 6—agree, and 7—strongly agree.

[a] Reverse code

Equipment layout for continuous flow		(Mean, S.D.)
EL1	We have laid out the shop floor so that processes and machines are in close proximity to each other	(5.33, 0.84)
EL2	The layout of our shop floor facilitates low inventories and fast throughput	(5.01, 0.97)
EL3	Our processes are located close together, so that material handling and part storage are minimized	(5.07, 0.93)
EL4	We have located our machines to support JIT production flow	(4.72, 0.98)
Just in time delivery by suppliers		(Mean, S.D.)
JT1	Our suppliers deliver to us on a just-in-time basis	(4.24, 1.15)
JT2	We receive daily shipments from most suppliers	(4.43, 1.31)
JT3	We can depend upon on-time delivery from our suppliers	(4.61, 1.03)
JT4	Our suppliers are linked with us by a pull system	(4.30, 1.09)
JT5	Suppliers frequently deliver materials to us	(4.97, 0.88)
Kanban		(Mean, S.D.)
KA1	Our suppliers deliver to us in kanban containers, without the use of separate packaging	(3.48, 1.24)
KA2	We use a kanban pull system for production control	(3.99, 1.36)
KA3	We use kanban squares, containers or signals for production control	(4.10, 1.39)
Setup time reduction		(Mean, S.D.)
ST1	We are aggressively working to lower setup times in our plant	(5.36, 0.84)
ST2	We have converted most of our setup time to external time, while the machine is running	(4.33, 0.99)
ST3	We have low setup times of equipment in our plant	(4.77, 0.92)
ST4	Our crews practice setups, in order to reduce the time required	(4.18, 1.21)
Statistical process control		(Mean, S.D.)
SPC1	A large percent of the processes on the shop floor are currently under statistical quality control	(4.77, 1.11)
SPC2	We make extensive use of statistical techniques to reduce variance in processes	(4.56, 1.03)
SPC3	We use charts to determine whether our manufacturing processes are in control	(4.87, 1.04)
SPC4	We monitor our processes using statistical process control	(4.78, 1.14)
		(continued)

Autonomous maintenance		(Mean, S.D.)
TPM1	Operators understand the cause and effect of equipment deterioration	(4.94, 0.78)
TPM2	Basic cleaning and lubrication of equipment is done by operators	(5.39, 0.95)
TPM3	Operators inspect and monitor the performance of their own equipment	(4.91, 0.86)
TPM4	Operators are able to detect and treat abnormal operating conditions of their equipment	(4.98, 0.79)

Soft-lean practices

Please indicate to what extent you agree/disagree with the following—(circle one number): 1—strongly disagree, 2—disagree, 3—slightly disagree, 4—neutral, 5—slightly agree, 6—agree, and 7—strongly agree.

[a] Reverse code

Top management leadership for quality		(Mean, S.D.)
TML1	All major department heads within the plant accept their responsibility for quality	(5.77, 0.78)
TML2	Plant management provides personal leadership for quality products and quality improvement	(5.69, 0.75)
TML3	Our top management strongly encourages employee involvement in the production process	(5.51, 0.83)
TML4	Our plant management creates and communicates a vision focused on quality improvement	(5.57, 0.85)
TML5	Our plant management is personally involved in quality improvement projects	(5.32, 0.81)
Supplier partnership		(Mean, S.D.)
SP1	We maintain cooperative relationships with our suppliers	(5.56, 0.57)
SP2	We provide a fair return to our suppliers	(4.95, 0.73)
SP3	We help our suppliers to improve their quality	(5.37, 0.63)
SP4	Our key suppliers provide input into our product development projects	(4.70, 0.79)
Small group problem solving		(Mean, S.D.)
SGPS1	During problem solving sessions, we make an effort to get all team members' opinions and ideas before making a decision	(5.18, 0.67)
SGPS2	Our plant forms teams to solve problems	(5.27, 0.87)
SGPS3	In the past three years, many problems have been solved through small group sessions	(5.04, 0.80)
SGPS4	Problem solving teams have helped improve manufacturing processes at this plant	(5.13, 0.83)
SGPS5	Employee teams are encouraged to try to solve their own problems, as much as possible	(5.16, 0.76)
SGPS6	We don't use problem solving teams much, in this plant[a]	(4.91, 0.91)
Continuous improvement		(Mean, S.D.)
CI1	We strive to continually improve all aspects of products and processes, rather than taking a static approach	(5.55, 0.68)
CI2	If we aren't constantly improving and learning, our performance will suffer in the long term	(5.87, 0.49)
CI3	Continuous improvement makes our performance a moving target, which is difficult for competitors to attack	(5.24, 0.85)
CI4	We believe that improvement of a process is never complete; there is always room for more incremental improvement	(5.82, 0.51)
CI5	Our organization is not a static entity, but engages in dynamically changing itself to better serve its customers	(5.51, 0.64)
		(continued)

Training employees		(Mean, S.D.)
TE1	Our employees receive training to perform multiple tasks	(5.19, 0.83)
TE2	Employees at this plant learn how to perform a variety of tasks	(5.25, 0.74)
TE3	The longer an employee has been at this plant, the more tasks they learn to perform	(5.17, 0.77)
TE4	Employees are cross-trained at this plant, so that they can fill in for others, if necessary	(5.18, 0.77)
TE5	At this plant, each employee only learns how to do one job[a]	(5.58, 0.79)
Customer involvement		(Mean, S.D.)
CUST1	We frequently are in close contact with our customers	(5.36, 0.77)
CUST2	Our customers give us feedback on our quality and delivery performance	(5.67, 0.79)
CUST3	We strive to be highly responsive to our customers' needs	(5.77, 0.51)
CUST4	We regularly survey our customers' needs	(5.27, 0.66)

Level of lean manufacturing implementation in respect to competitors

Please circle the number that indicates your opinion about how your plant compares to its competition in your industry, on a global basis: 5—superior, 4—better than average, 3—average or equal to the competition, 2—below average, and 1—poor or low.

		(Mean, S.D.)
LEAN	Lean manufacturing	(3.28, 0.71)

Operational performance in respect to competitors

Please circle the number that indicates your opinion about how your plant compares to its competitors in your industry, on a global basis: 5—superior, 4—better than average, 3—average or equal to the competition, 2—below average, and 1—poor or low.

		(Mean, S.D.)
PER1	Unit cost of manufacturing	(3.26, 0.89)
PER2	Quality conformance	(3.86, 0.69)
PER3	On time delivery performance	(3.83, 0.85)
PER4	Fast delivery	(3.74, 0.83)
PER5	Flexibility to change product mix	(3.85, 0.76)
PER6	Flexibility to change volume	(3.79, 0.81)

We used the following formula to compute the performance score:

Equation (A.1)

$$\mathrm{PER} = \frac{(\mathrm{PER1} + \mathrm{PER2} + \mathrm{PER3} + \mathrm{PER4} + \mathrm{PER5} + \mathrm{PER6})}{6}$$

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