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An exploratory research about lean manufacturing implementation and behaviors of multi-level leadership

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Abstract

The culture of lean implementation is considered as a key element for its long-term sustainability and leaders play a crucial role, since they are responsible for influencing individuals and teams. This article aims at empirically examining the relationship between the behavioral orientation of leaders from different hierarchical levels (middle managers and frontline leaders) and the implementation phase of the Lean Manufacturing (LM) roadmap. The proposed method relies on both qualitative and quantitative fronts since it combines the results of semi-structured interviews with lean experts and a cross-sectional survey with 225 leaders from different Brazilian companies that are undergoing LM implementation. The study bridges a gap observed in the literature regarding LM implementation, as it enables the identification of the relationship between multi-level leadership styles and the implementation phases of LM roadmap. The findings support the existence of a transient leadership style orientation along the Lean implementation and provide evidence that there is not a single best leadership style for lean implementation.

Keywords
lean manufacturing implementation; leadership behaviors; lean roadmap.

1. Introduction

Lean manufacturing (LM) implementation entails fundamental changes in companies' managerial systems, across the organizational and department levels (Wan and Chen, 2008). The LM implementation is about changing both technical and socio-cultural aspects (Tortorella and Fogliatto, 2014), which can be seen as the essence of leadership (Schein, 2004), since such implementation creates expectations regarding leaderships' attributes and behaviors (House et al., 2004). Further, it is important to approach the underlying culture of lean implementation, considered as a key element for its long-term sustainability (Hines et al., 2004). Thus, leaders play a crucial role in the establishment of such lean culture, since they are responsible for influencing individuals and teams towards the achievement of strategic objectives (Sethuraman and Suresh, 2014). Particularly in a lean change, usually 20% of the effort is related to the implementation of lean practices, while 80% focuses on changing leaders' behaviors (Mann, 2009).

Previous studies, e.g. Womack and Jones (2003) and Spear (2004), have highlighted the importance of a lean leadership and the development of certain attributes such as commitment and communication skills. Gelei et al. (2015) investigate the leadership attributes that contribute to (or inhibit) a successful lean implementation. A common belief is that lean leaders should be cooperative, delegators and excellent motivators of personnel (Angelis et al., 2011). However, the analysis is usually undertaken from the perspective of high maturity companies such as Toyota, neglecting the evolutionary nature of the implementation process, and its resulting demands for adaptive and transient leaderships' behaviors (Marksberry, 2010). Further research indicates that a successful lean implementation demands transformational leaders at the top (Suresh et al., 2012) demonstrating the desired behaviors towards the expected culture and outcomes, which must be carried out by transactional leaders in middle management levels (Emiliani, 2008; van Dun et al., 2016). Therefore, it is noteworthy the scarcity of detailed studies concerning the desirable behaviors of leadership from different hierarchical levels along the evolution of lean roadmap implementation, as claimed by Liker (2004), Mann (2009), Liker and Convis (2013), and Dombrowski and Mielke (2014).

From a practical perspective, such gap is observed in many organizations still struggling to succeed in LM implementation due to leadership issues (Emiliani and Stec, 2005). The relevant question that arises here is whether leaders' behaviors from different hierarchical levels should be adapted according to the stage of LM implementation and the contextual variables that surround leadership. In order to assess that question, two hierarchical levels were of interest in this study: middle managers and frontline leaders. The first level (middle managers) is usually responsible for translating the organizational strategy into operational routines; lean initiatives then often fall upon middle managers (van Dun et al., 2016). Complementarily, the second level (frontline leaders) is the one closer to the value-added points and in charge of verifying operational standards (Marksberry, 2010). We understand that not only the lean roadmap phase in which the company is situated must be taken into account as determinant to leadership's behavior, but also the hierarchy level and factors, such as number of followers, leadership experience and leaders' age. Therefore, we propose three research questions: (i) "how do different leadership styles can contribute as the evolutionary pattern of a LM roadmap implementation takes place?"; (ii) "what are the behavioral differences of leaders from different hierarchical levels along the LM implementation?"; and (iii) "which is the role of the team size and the leaders' age and experience in such contribution?".

Following the proposed research questions, this article aims at empirically examining the relationship between the behavioral orientation of leaders from different hierarchical levels (middle managers and frontline leaders) and the implementation phase of the LM roadmap. In addition, it also aims at analyzing the influence of inherent contextual variables related to leadership. The proposed method relies on both qualitative and quantitative fronts, since it combines and numerically assesses the results of semi-structured interviews with lean experts, in addition to evaluating a cross sectional survey with 225 leaders from different Brazilian companies that are undergoing LM implementation.

Our study bridges a gap observed in the literature regarding LM implementation, as it enables the identification of the relationship between multi-level leadership styles and the implementation phases of LM roadmap. Further, we investigate the effect of contextual variables on such relationship. Achieving a successful lean enterprise comprises an evolutionary process that may require different leadership styles according to the context in which the leader is inserted. Thus, this research provides arguments to understand the transformational role of leaders, and the recommended behaviors along the lean implementation. Our goal is to complement existing lean roadmaps by considering the proper leadership style as a contingency issue in leadership-related aspects of the lean implementation process. Moreover, identifying the effect of contextual variables may contribute to specify the contexts in which LM implementation is expected to occur. The research specifically focuses on three leadership contextual variables: (i) leader's age, (ii) size of the team (number of followers) and (iii) leadership experience. We are not aware of any other method that is comparable to ours regarding its objectives.

2. Literature review

2.1 Leadership styles

The relationship between interpersonal skills and leadership performance began to be studied after the Second World War. Several researchers began to examine the association between company's performance, leadership practices and individual development (Hunt and Baruch, 2003). Since then, the influence of leadership style on job performance, satisfaction, stress, and turnover intention has been extensively studied (Chen and Silverthorne, 2005; Wilson and Thompson, 2014). Despite the fact that leadership style influences on several aspects of the organization, successful leaders usually do not rely on a single leadership style.

The situational leadership (SL) model developed by Hersey and Blanchard (1969; Hersey et al., 2001) is one of the best known leadership characterization models (Papworth et al., 2009), since it provides a means to effectively change individuals' working habits through cooperation and communication to enhance productivity (Pasaribu, 2015). SL is grounded on three leadership dimensions, two of them associated with leadership style: relationship behavior (R), and task behavior (T). The model considers two levels for these dimensions (high and low). Thus, when combined, these dimensions result into four different styles.

Leaders that are highly focused on the tasks and present low relationship intensity with followers are said to be "telling" or "directing" (S1). This style is usually recommended to teams in which followers cannot perform the job and are unwilling to try; the leader then takes a highly directive role, telling them what to do without any concern regarding the relationship. The second style (S2, selling/coaching), denoted by a concern of the leadership with both the task accomplishment and the relationship level, is suitable for situations in which followers can perform the job at least to some extent, and are motivated about it. In the "participating" or "supporting" style (S3), leaders are less

focused on the task, but remain concerned with relationship. This style is suggested for followers that are highly competent for performing the tasks, but unwilling or insecure to do so. Finally, style S4 (delegating or observing) presents a low leadership's focus on both task and relationship, being indicated for high performing and motivated followers, denoting high levels of readiness (Blanchard et al., 1985; Hersey et al., 2001; Blanchard, 2010).
Leaders should adapt their style according to the followers' maturity, based on how ready and willing the followers are to perform the required tasks or, in other words, based on how competent and motivated they are (Hersey and Blanchard, 1996; Papworth et al., 2009). Leadership effectiveness is maximized by properly matching the leadership style to individuals' maturity level (Maj, 2011). In this sense, as individuals become more mature, the ideal leadership style changes accordingly (Aric, 2007). A key assumption of the SL model is that it is possible to determine the appropriate leadership style in response to followers' maturity level. Thus, followers may accept or reject a leader, whose style flexibility seems to deliver greater performance (Blanchard et al., 1985).
Criticism of the SL model among scholars (Vecchio et al., 2006) contrasts with the model´s popularity among practitioners (Jain and Chaudhary, 2014), who report the its application as a supporting tool to assess leadership styles. The continued applicability of the model is reinforced by the recent appearance of a revised version of its main data collection instrument, the Leadership Effectiveness and Adaptability Description (LEAD) (Blanchard, 2010). The questionnaire provides a classification of leadership styles based on task and relationship behaviors, exposing respondents to different workplace situations and asking for answers that describe how they would react to them. The objective is to determine how leaders behave on the job and the propensity to adapt the leadership style.
Further studies have expanded the discussion regarding the effective leadership styles. Sethuraman and Suresh (2014) complement the SL theory by investigating the influence of leaders' personality type on leadership behavior through the application of Myers Briggs Type Indicator (MBTI). Thompson and Glaso (2015) aimed to quantify the followers' need from three perspectives: (i) measuring followers' competence; (ii) examining the leader-follower dynamic along a continuum of job levels; and (iii) comparing degree of self-other agreement in follower competence and commitment ratings to identify whether higher correlation more adequately validates the SL model. Additionally, Pasaribu (2015) investigates the influence of SL behavior, organizational culture and implementation of human resources management strategies on productivity at a private training institute. Despite evidences from previous research, leadership is yet a highly studied theme, and still offers opportunities for investigation, especially in companies undergoing a lean implementation (Bortolotti et al., 2015).

2.2 Lean manufacturing practices

The adoption of lean practices requires a change in the management of workers and in job design. The challenge lies on justifying and examining why and under which conditions the lean practices have competitive value and contextual relevance (Ketokivi and Schroeder, 2004). Thus, the selection of appropriate practices for process improvement and the identification of their applicability in operations feature an additional issue for leaders.
Several studies addressed the subject of lean implementation assessment (Shah and Ward, 2007; Wan and Chen, 2008; Tortorella and Fogliatto, 2014). In general, these studies relate the adoption level of lean to the extent of implementation of a set of corresponding management practices.
Table 1 consolidates the most frequent LM practices evidenced in literature. Fifteen widely deemed studies were selected, highlighting nineteen LM practices as the most cited ones. From these, two practices (standardized work and problem solving methods) seem to be the most frequently evidenced in the investigated literature. The first one appears to be applied under different motivational reasons: (i) to create basic stability in production processes by mitigating process variability (Doolen and Hacker, 2005; Stentoft and Vagn, 2013), (ii) to balance workload among employees as observed by Shah and Ward (2007) and Bortolotti et al. (2015), and (iii) to emphasize quality procedures and key daily routines (Furlan et al., 2011; Bhamu and Singh Sangwan, 2014). Despite its relevance, the research efforts aligned with the second practice have been recently associated with LM literature (Netland et al., 2015; Marodin et al., 2015). This fact may be justified by the evolutionary comprehension of LM and its practices, which have achieved different patterns of understanding along time (Hines et al., 2004). However, this practice is usually associated with the capacity of solving problems in a structured way, regardless of the kind and criticality of the problem under analysis. The least cited practice (4 out of 15 references) 'organizational design'. Although organizational design is often considered an important element in a successful lean implementation, a great deal of variance emerges from the literature regarding how this practice is defined and implemented (Furlan et al., 2011; Netland et al., 2015).

Table 1. LM practices in literature

LM practices	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	Agreement
1-Flexible manpower	X		X			X		X	X	X	X		X	X	X	67%
2-Pull system	X	X		X		X	X	X	X	X	X	X		X	X	80%
3-Takt time	X	X		X		X		X				X		X	X	53%
4-Continuous flow	X	X		X		X	X	X	X	X	X	X		X	X	80%
5-Material supply	X	X	X	X			X	X	X	X	X	X		X	X	80%
6-Zero defects	X	X			X	X	X	X	X	X				X	X	67%
7-Quality assurance	X	X	X	X				X	X	X				X	X	60%
8-Product / process quality planning	X		X	X	X			X	X	X		X		X	X	67%
9-Standardized work	X	X		X	X		X	X	X	X	X	X	X	X	X	87%
10-Production levelling	X			X	X	X	X	X	X	X	X	X		X	X	80%
11-Maintenance system	X	X		X		X	X	X	X	X	X	X		X	X	80%
12-Workplace organization	X	X					X	X	X	X	X	X	X	X	X	73%
13-Goal oriented teams	X					X	X			X	X		X	X	X	53%
14-Cross functional work		X		X	X					X	X			X		40%
15-Organizational design				X	X					X				X		27%
16-Problem solving methods	X		X		X	X	X	X	X	X	X	X	X	X	X	87%
17-Improvement organization			X	X		X				X	X		X	X		47%
18-Prioritization				X		X	X		X	X	X		X	X	X	60%
19-Improvement approach	X			X			X		X	X			X	X	X	53%

Authors: (1) Shah and Ward, 2003; (2) Doolen and Hacker, 2005; (3) Treville and Antonakis, 2006; (4) Shah and Ward, 2007; (5) Furlan et al., 2011; (6) Stone, 2012; (7) Moyano-Fuentes and Sacristán-Díaz, 2012; (8) Marodin and Saurin, 2013; (9) Stentoft and Vagn, 2013; (10) Netland and Ferdows, 2014; (11) Bhamu and Singh Sangwan, 2014; (12) Jasti and Kodali, 2015; (13) Bortolotti et al., 2015; (14) Netland et al., 2015; (15) Marodin et al., 2015.

2.3. Lean implementation roadmaps

LM relies on two key principles: continuous improvement and respect for people (Emiliani and Stec, 2005). The first one embodies practices and techniques used to improve quality and productivity (Ohno, 1988). The second principle comprises leadership behaviors and business practices that must be consistent with efforts to eliminate waste and create value for end-use customers (Treville and Antonakis, 2006). Despite the simplicity of its principles, the literature on LM is prolific and several lean implementation roadmaps have been proposed, some of which are discussed here. Liker and Meier (2007) recommend that LM implementation processes should start by addressing the 4 P's (philosophy, process, people, and problem solving). Based on that, the Lean Enterprise Institute – LEI (2010) proposes a roadmap in which the first step consists of establishing a training program to develop the principles of lean thinking in individuals. The first goal is to develop expertise on Value Stream Mapping, in order to avoid the common mistake of applying single techniques instead of creating a system that builds a lean value stream. Although not emphasizing the importance of assessing the LM implementation level, the roadmap in LEI (2010) is flexible and allows customization according to the application environment and stage in which the organization is positioned.

Productivity Inc. (2010) presents a model comprised of five phases to guide the LM implementation. The model provides a sequence of steps which emphasize the importance of teamwork as a basis for lean implementation; however, it does not motivate a sense of "urgency for change", which should be strongly linked to the decision of adopting LM. With similar purposes, Crabill et al. (2000) describe the Lean Enterprise Model (LEM), which aims at establishing a systematic implementation of lean principles and practices by integrating perspectives from engineering, human resources and the business itself (Figure 1). The LEM, comprised of eight implementation phases, was based on six already tested transition models, providing a guide for transforming an existing production operation to one that fully implements LM. Each LEM phase ensures that tasks prescribed in prior phases are finished or under consideration before proceeding to the next phase. However, the LEM model does not identify leadership style needs in the organization at each roadmap phase; that is addressed in the proposed method presented in the next section. Furthermore, no phase clearly specifies the set of lean practices that should be preferentially adopted by companies, resulting in a broad and potentially ambiguous approach that may compromise its success when carried out by leaders and practitioners.

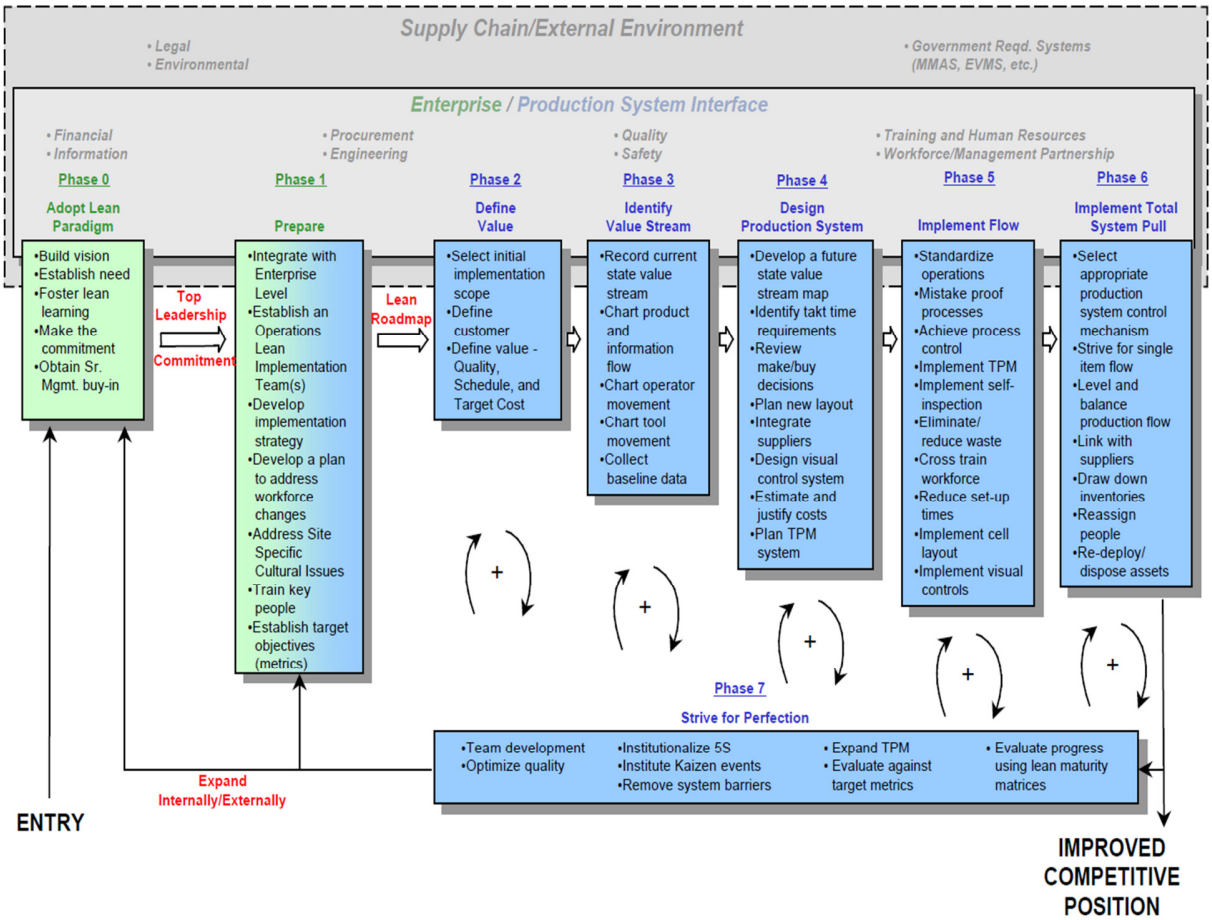

Figure 1. Phases of LEM roadmap
Source: Adapted from Crabill et al. (2000)

3. Research method

3.1. Definition of the most suitable set of lean practices for each phase of the LEM roadmap

The first step relies on defining the set of lean practices more suitable for each phase of the LEM roadmap. To accomplish that, we used semi-structured interviews with eight lean experts presenting at least 15 years of experience in LM implementation in automotive large-sized companies. Before starting each interview, a brief explanation defining each phase of the LEM roadmap was carried out. According to Kothari (2004), such explanation may avoid misinterpretations along the interview, reducing the occurrence of erroneous responses. Experts were asked to indicate the lean practices lp_z (z=1,…,19) more suitable for each phase of the LEM roadmap based on our literature review on LM practices (see Table 1). Experts were then invited to answer the following question: "what is the relationship intensity r_{zj} between lean implementation phase p_j and the LM practice lp_z?". Intensities r_{zj} were expressed using a [0, 1] continuous scale, with 0 denoting no relationship and 1 representing maximum relationship. Responses were consolidated using the average of responses weighted by experts' years of experience.

To better compare the relationship intensity values, we proposed a differentiation index (DI) that gives the number of standard deviations of each consolidated processed response with respect to the average of the lp_z. The standardized scores, usually applied in qualitative studies, remove scale effects and emphasize the differences between the responses (i.e. large positive differentiation values indicate the most suitable practices). In our propositions, we assume that standardized scores larger than 1.0 are considered as the most suitable ones for the phase, and then used to assess company's maturity for the corresponding phase of the LEM roadmap.

As companies follow through the LEM roadmap, phases' requirements may be refined and demand the integration of specific LM practices; however, it is not allowed to neglect practices adopted in previous phases. In this sense,

the arrangement of LM practices according to the LEM roadmap phase is a cumulative process, in which practices indicated as suitable in a previous phase are understood as necessary for later phases. Thus, practices that present a differentiation index higher than 1.0 are included in the phase p_j without disregarding practices previously ranked as suitable.

3.2. Questionnaire development and data collection

We used the following criteria to select companies and respondents. First, we targeted at companies (a) undergoing lean implementation, and (b) geographically located in the south of Brazil, in order to control the effect of environmental factors (e.g. availability of skilled labour). Non-random selection of companies in lean surveys is a common approach; e.g. Boyle et al. (2011). Second, respondents should have experience in lean and present a leadership role in the company, such as Middle Manager or Frontline Leader. Questionnaires were sent by e-mail to 387 leaders that attended the National Conference on Lean Systems in June 2015. A first e-mail message containing the questionnaires was sent in early July 2016, and two follow-ups were sent in the following weeks. The final sample was comprised of 225 valid responses (representing a response rate of 58.14%).
The obtained sample presented a balanced amount of companies for each contextual variable. Most respondents belonged to large companies (72%); the majority of companies were related to the automotive supply chain (41%). Most respondents had up to 2 years of leadership experience (61%), and more than 30 years old (52%). Further, most respondents were male (68%), and directly lead teams comprised by more than 5 followers (52%). Finally, regarding the job position, there was a predominance of Frontline Leaders (57%) within the sample.
The questionnaire had three parts. The first part aimed to collect demographic information of respondents and their companies. The contextual variables 'leader's age', 'leadership experience' and 'number of followers' were categorized. Leadership experience was coded according to Hunt and Baruch (2003) findings, which suggest that leaders with less than two years of experience may be considered as beginners and may present lower levels of interpersonal skills and maturity. As for the number of followers, two categories were proposed: (i) teams comprised of more than 5 followers and (ii) teams with five followers or less. This categorization was based on Schaubroeck's et al. (2007) research, which indicates that teams with five followers in average might achieve better results than larger teams. Finally, the variable 'leader's age' was divided into two categories: (i) leaders younger than thirty years-old and (ii) leaders older than thirty years-old.
The second part assessed the leadership style of respondents. For that, we adapted the LEAD (Leadership Effectiveness & Adaptability Description), originally developed by Blanchard and Hersey (1969) and improved by Blanchard (2010), to be carried out in an organizational environment undergoing lean implementation.
Finally, the third part of the questionnaire aimed at measuring the degree of adoption of the nineteen LM practices described in the literature (Table 1). Each question was answered based on a 5-point scale ranging from 1 (not used) to 5 (fully adopted). Further, we tested for non-response bias as proposed by Armstrong and Overton's (1977) using Levene's test for equality of variances and a t test for the equality of means between early and late respondents. Results indicated no differences in means and variation in the two groups, with 95% significance. Further, we tested all responses related to the 19 LM practices for reliability determining their Cronbach's alpha values. The LM practices displayed high reliability, with Cronbach's alpha value of 0.889.

3.3. Data Clustering

The proposed method performs the clustering of observations of the implementation level of LM practices according to each LEM roadmap phase. The objects within a cluster must be similar to the other inserted into the same cluster (homogeneity), and different from other objects embedded in other clusters (denoting heterogeneity) (Rencher, 2002). The *k*-means clustering technique (where *k* defines the number of clusters to be generated) allocates each observation to the cluster centroid presenting the smallest Euclidean Distance to that observation. Thus, we applied the *k*-means method setting k=2, which corresponds to the levels of LM implementation (HL_j=high level or LL_j=low level). In this sense, we propose to assess companies' maturity throughout the LEM roadmap according to the implementation level of incremental subsets of LM practices. This procedure was carried out for each of the eight LEM roadmap phases p_j and to their respective LM practices. However, if a company is poorly implementing the practices of a certain phase it is quite likely that practices from later phases are not effectively adopted, since these tend to be more complex and may present some pre-requisites. Therefore, responses with the lowest implementation level of previous phase's LM practices should be removed from the sample before performing the subsequent clustering. We adopted a threshold value of 20% of the previous LL_j group to be removed of the next analysis. At

each iteration the average difference between both groups was tested by means of a variance analysis (ANOVA), which confirmed a significant difference between the average implementation levels of all LM practices.

3.4. Data analysis

Observations belonging to each cluster regarding the LM implementation level were then assessed in terms of the three contextual variables and the two hierarchical levels aforementioned at each LEM roadmap phase. To verify the adherence to normal distribution we used the Kolmogorov-Smirnof (KS) test. We applied the Mann-Whitney test to verify the existence of any significant difference among averages of leaders' behavior regarding task and relation orientation in companies widely adopting LM practices at each LEM roadmap phase. Further, this technique is an alternative to parametric tests, in which homocedasticity and data adherence to normal distribution are required (Siegel and Castellan Jr, 1988).

4. Results

Table 2 displays the consolidated values for r_{zj} and their corresponding standardized scores. For companies in Phase 0, LM_8 (product/process quality planning) and LM_{18} (prioritization) seem to be the most suitable for implementation. As companies prepare their LM implementation (Phase 1), experts indicate that practices LM_{12} (workplace organization) and LM_{15} (organizational design) should be integrated into the management systems. As companies define value according to customers' perspective (Phase 2), results suggest that LM_3 (takt time) and LM_7 (quality assurance) may be reinforced in order to favor the outcomes of this phase. For properly identifying the flow of value, which features the Phase 3 of LEM roadmap, practices LM_9 (standardized work) and LM_{19} (improvement approach) appear to be helpful and should be incorporated into current subset of LM practices. For companies undergoing the Phase 4 (design production system), besides the practices already adopted, practices LM_{11} (maintenance system), LM_{14} (cross functional work) and LM_{16} (problem solving methods) should be emphasized to better support such implementation. During the phase of flow implementation (Phase 5), experts recommend that the subset of practices should include LM_1 (flexible manpower) and LM_6 (zero deffects) in order to corroborate with the phase's objectives. Practices LM_2 (pull system), LM_4 (continuous flow), LM_5 (material supply) and LM_{10} (production levelling) may receive special attention by companies undergoing the implementation of Phase 6, since this phase aims at delivering to customers with appropriate mix and quantity. Finally, for companies at Phase 7 (look for perfection), all nineteen LM practices are recommended and should be consistent and systemically adopted, with particular importance to the inclusion of LM_{13} (goal oriented teams) and LM_{17} (improvement organization) to current management systems.

Table 2. Indication of LM practices according to LEM roadmap phases and size of clusters HL_j and LL_j

LM practices	Phase 0		Phase 1		Phase 2		Phase 3		Phase 4		Phase 5		Phase 6		Phase 7	
	r_{z0}	DI	r_{z1}	DI	r_{z2}	DI	r_{z3}	DI	r_{z4}	DI	r_{z5}	DI	r_{z6}	DI	r_{z7}	DI
LM_1	0.23	-1.22	0.43	-0.51	0.50	-0.20	0.45	-1.50	0.66	0.91	0.72	**1.68***	0.60	0.03	0.55	-0.11
LM_2	0.39	-0.17	0.34	-1.55	0.48	-0.42	0.52	-0.55	0.50	-0.59	0.60	0.35	0.77	**1.43***	0.65	0.78
LM_3	0.43	0.09	0.54	0.76	0.70	**1.95***	0.56	-0.01	0.55	-0.12	0.55	-0.20	0.54	-0.46	0.50	-0.56
LM_4	0.23	-1.22	0.46	-0.16	0.51	-0.10	0.54	-0.28	0.49	-0.68	0.61	0.46	0.78	**1.51***	0.67	0.96
LM_5	0.12	-1.94	0.48	0.07	0.47	-0.53	0.47	-1.23	0.56	-0.02	0.63	0.68	0.80	**1.67***	0.66	0.87
LM_6	0.50	0.55	0.55	0.87	0.40	-1.28	0.55	-0.14	0.65	0.82	0.75	**2.01***	0.65	0.44	0.59	0.25
LM_7	0.45	0.22	0.55	0.87	0.73	**2.27***	0.60	0.54	0.44	-1.15	0.49	-0.87	0.45	-1.20	0.42	-1.28
LM_8	0.67	**1.66***	0.53	0.64	0.55	0.33	0.49	-0.96	0.49	-0.68	0.54	-0.32	0.53	-0.54	0.49	-0.65
LM_9	0.52	0.68	0.51	0.41	0.60	0.87	0.69	**1.76***	0.45	-1.05	0.57	0.02	0.55	-0.38	0.54	-0.20
LM_{10}	0.43	0.09	0.44	-0.39	0.39	-1.39	0.48	-1.10	0.52	-0.40	0.65	0.90	0.76	**1.34***	0.65	0.78
LM_{11}	0.34	-0.50	0.37	-1.20	0.44	-0.85	0.62	0.81	0.72	**1.47***	0.58	0.13	0.50	-0.79	0.50	-0.56
LM_{12}	0.56	0.94	0.63	**1.80***	0.46	-0.63	0.51	-0.69	0.57	0.07	0.58	0.13	0.49	-0.87	0.47	-0.83
LM_{13}	0.35	-0.43	0.43	-0.51	0.50	-0.20	0.59	0.40	0.41	-1.43	0.40	-1.87	0.69	0.77	0.78	**1.95***
LM_{14}	0.41	-0.04	0.42	-0.63	0.52	0.01	0.63	0.95	0.75	**1.75***	0.59	0.24	0.59	-0.05	0.60	0.34
LM_{15}	0.56	0.94	0.65	**2.03***	0.45	-0.74	0.55	-0.14	0.43	-1.24	0.40	-1.87	0.41	-1.53	0.42	-1.28
LM_{16}	0.39	-0.17	0.38	-1.09	0.43	-0.96	0.61	0.67	0.77	**1.94***	0.60	0.35	0.59	-0.05	0.58	0.16
LM_{17}	0.40	-0.10	0.40	-0.86	0.54	0.23	0.48	-1.10	0.59	0.26	0.55	-0.20	0.68	0.69	0.76	**1.77***
LM_{18}	0.70	**1.86***	0.51	0.41	0.58	0.66	0.60	0.54	0.58	0.16	0.51	-0.65	0.48	-0.96	0.42	-1.28
LM_{19}	0.21	-1.35	0.39	-0.97	0.61	0.98	0.71	**2.04***	0.56	-0.02	0.48	-0.98	0.47	-1.04	0.44	-1.10
HL_j	95		83		71		56		44		37		35		34	
LL_j	130		117		105		100		91		80		65		53	
	Size of clusters (n) per phase															

Practices indicated as the most suitable for the corresponding phase of the LEM roadmap
Gray cells represent the accumulated subset of practices recommended for the corresponding phase

Table 3 depicts the results for the contingency table with the chi-square test for frontline leaders' style orientation according to each contextual variable at each LEM roadmap phase. Results indicate that only 'number of followers' appears to significantly influence frontline leaders' behaviors out of the three contextual variables assessed. Further, the effect of this variable is evidenced only at Phases 1, 2, 4 and 5, in which the relation orientation of frontline leaders is mainly affected. Overall, results suggest that frontline leaders that are extensively adopting the corresponding LM practices and lead smaller teams (< 5 followers) seem to be more relation-oriented than the ones responsible for larger teams (≥ 5 followers). This result is consistent with the findings of Aric (2007) and Schaubroeck's et al. (2007), which indicate that leaders with smaller teams are more likely to focus their behaviors on the relation with their followers. Such style adaptation is eventually feasible due to the reduced amount of followers, allowing the leader to include in his management routine the proper time to reinforce his soft skills, such as coaching, feedback and recognition (Marksberry, 2010). In opposition, Frontline Leaders who manage larger teams and widely adopt LM practices in each one of the aforementioned phases also provide focus on the relation, but probably the frequency in which such behaviors are demonstrated is lower.

Particularly at Phase 1, the task orientation seems to be also influenced by the number of followers, indicating that frontline leaders with smaller teams tend to be more task-oriented than the ones with larger teams. This result is somewhat surprising in light of conventional wisdom about lean change. Evidences from literature (e.g. Papworth et al., 2009; Pasaribu, 2015) suggest that leaders with larger teams tend to be more task-oriented, since they have to accomplish targets regardless the followers' relationship. Hence, the available time to properly adapt their style to relation-oriented is shorter. However, in companies undergoing the phase of preparation for LM implementation, Frontline Leaders with smaller teams appear to be highly involved with activities. According to Spear (2004), and Liker and Convis (2011), the high degree of specification and structure in a lean enterprise does not promote the command and control environment one might expect. Indeed, this leadership behavior actually stimulates followers to engage in the kind of experimentation that is widely recognized as the cornerstone of a learning organization. Our results corroborate with that statement and evidence that this leadership behavioral pattern is also observed in Frontline Leaders with small teams and at the beginning of the LM implementation.

Regarding Middle Managers' style orientation in companies with high implementation levels of LM practices, Table 4 shows the results at each phase of the LEM roadmap according to the contextual variables. Analogously to Frontline Leaders, Middle Managers' behaviors seem to be highly influenced by the number of followers that they lead. However, this effect is observed only on the task orientation of Middle Managers at all phases, except Phase 7 in which the styles orientation are not significantly associated with any of the contextual variables. Contrary to the obtained results for Frontline Leaders at Phase 1, our results indicate that Middle Managers are more task-oriented in contexts with larger teams, regardless the phase of LEM roadmap.

According to Liker (2004), Middle Managers are supposed to guide the deployment and achievement of the companies' strategic objectives. Further, they are in charge of orienting, developing and verifying the behaviors and skills of Frontline Leaders on their daily duties (Mann, 2009). Therefore, it is reasonable to expect that Middle Managers with larger teams present a higher task orientation to ensure the accomplishment of a diversity of activities included in their routines.

Specifically at Phases 4 and 5, leadership experience appears to be significantly associated with the intensity of task orientation of Middle Managers. Less experienced leaders (≤ 2 years) seem to demonstrate more frequently task-oriented behaviors. These phases aim at designing the production system design and implementing the improvement projects. In this context, Emiliani (2008) states that Middle Managers often assume that their followers are not sufficient knowledgeable or mature to undertake these activities by themselves. Hence, they usually end up overburden due to the high level of control and specification that they tend to apply. Our results indicate that such emphasis on task orientation is particularly apparent in behaviors of less experienced Middle Managers.

Table 3. Mann-Whitney test for Frontline Leaders' behavioral orientation according to LEM roadmap phases and contextual variables in HL

LEM roadmap	Leadership style orientation	Age						Number of followers						Leadership experience					
		≤ 30 years old			> 30 years old			< 5 followers			≥ 5 followers			≤ 2 years			> 2 years		
		n	Mean	Std. dev.	*n*	Mean	Std. dev.	*n*	Mean	Std. dev.	*n*	Mean	Std. dev.	*n*	Mean	Std. dev.	*n*	Mean	Std. dev.
Phase 0	Task	41	0.53	0.22	11	0.58	0.14	41	0.56	0.20	11	0.45	0.21	45	0.53	0.21	7	0.57	0.17
	Relation		0.65	0.13		0.62	0.12		0.65	0.13		0.61	0.12		0.64	0.13		0.65	0.13
Phase 1	Task	35	0.55	0.21	11	0.57	0.16	36	**0.58***	**0.19**	10	**0.46***	**0.21**	41	0.55	0.20	5	0.61	0.18
	Relation		0.65	0.13		0.61	0.12		**0.66****	**0.12**		**0.56****	**0.08**		0.64	0.12		0.65	0.14
Phase 2	Task	24	0.52	0.20	11	0.53	0.17	25	0.55	0.18	10	0.45	0.21	30	0.51	0.20	5	0.59	0.17
	Relation		0.64	0.14		0.58	0.13		**0.65****	**0.14**		**0.56****	**0.12**		0.62	0.14		0.66	0.13
Phase 3	Task	23	0.50	0.22	11	0.58	1.13	24	0.54	0.20	10	0.50	0.20	29	0.51	0.20	5	0.61	0.18
	Relation		0.66	0.15		0.60	0.10		0.66	0.14		0.59	0.12		0.64	0.14		0.65	0.14
Phase 4	Task	17	0.52	0.22	9	0.58	0.13	19	0.56	0.19	7	0.50	0.22	21	0.53	0.20	5	0.61	0.18
	Relation		0.65	0.14		0.60	0.10		**0.66****	**0.13**		**0.56****	**0.09**		0.63	0.13		0.65	0.14
Phase 5	Task	15	0.52	0.23	8	0.57	0.14	17	0.56	0.20	6	0.47	0.23	18	0.51	0.21	5	0.61	0.18
	Relation		0.64	0.14		0.59	0.11		**0.65***	**0.13**		**0.54***	**0.08**		0.62	0.13		0.65	0.14
Phase 6	Task	13	0.54	0.21	8	0.59	0.15	15	0.55	0.20	6	0.58	0.17	16	0.54	0.19	5	0.62	0.21
	Relation		0.62	0.15		0.62	0.11		0.64	0.14		0.56	0.12		0.60	0.13		0.68	0.14
Phase 7	Task	12	0.48	0.23	8	0.56	0.13	14	0.52	0.20	6	0.50	0.22	15	0.48	0.20	5	0.61	0.18
	Relation		0.62	0.14		0.58	0.10		0.63	0.14		0.56	0.09		0.59	0.12		0.65	0.14

* significant at 10% / ** significant at 5% / *** significant at 1%

Table 4. Mann-Whitney test for Middle Managers' behavioral orientation according to LEM roadmap phases and contextual variables in HL

LEM roadmap	Leadership style orientation	Age						Number of followers						Leadership experience					
		≤ 30 years old			> 30 years old			< 5 followers			≥ 5 followers			≤ 2 years			> 2 years		
		N	Mean	Std. dev.	*N*	Mean	Std. dev.	*n*	Mean	Std. dev.	*n*	Mean	Std. dev.	*n*	Mean	Std. dev.	*n*	Mean	Std. dev.
Phase 0	Task	8	0.53	0.23	35	0.60	0.20	5	**0.51***	**0.19**	38	**0.59***	**0.21**	14	0.57	0.23	29	0.59	0.20
	Relation		0.64	0.16		0.64	0.13		0.66	0.16		0.63	0.14		0.63	0.16		0.64	0.13
Phase 1	Task	8	0.58	0.15	29	0.57	0.21	4	**0.39***	**0.18**	33	**0.59***	**0.19**	10	0.58	0.24	27	0.57	0.18
	Relation		0.64	0.15		0.61	0.14		0.56	0.17		0.62	0.14		0.61	0.15		0.62	0.14
Phase 2	Task	7	0.56	0.14	29	0.57	0.22	4	**0.41***	**0.16**	32	**0.59***	**0.20**	10	0.59	0.22	26	0.55	0.19
	Relation		0.63	0.15		0.60	0.14		0.54	0.15		0.61	0.14		0.59	0.15		0.61	0.14
Phase 3	Task	4	0.50	0.13	18	0.55	0.20	4	**0.39***	**0.18**	18	**0.57***	**0.18**	5	0.61	0.13	17	0.52	0.20
	Relation		0.56	0.16		0.62	0.16		0.56	0.17		0.62	0.16		0.66	0.18		0.51	0.15
Phase 4	Task	4	0.50	0.13	14	0.58	0.20	4	**0.39***	**0.18**	14	**0.61***	**0.16**	3	**0.66***	**0.16**	15	**0.54***	**0.19**
	Relation		0.56	0.16		0.59	0.16		0.56	0.17		0.59	0.16		0.67	0.25		0.57	0.14
Phase 5	Task	3	0.50	0.17	11	0.59	0.15	3	**0.47***	**0.12**	11	**0.60***	**0.15**	3	**0.66***	**0.16**	11	**0.55***	**0.15**
	Relation		0.52	0.17		0.61	0.18		0.55	0.21		0.60	0.17		0.67	0.25		0.57	0.16
Phase 6	Task	3	0.50	0.17	11	0.60	0.17	3	**0.44***	**0.09**	11	**0.62***	**0.17**	3	0.62	0.15	11	0.57	0.18
	Relation		0.52	0.17		0.59	0.16		0.47	0.12		0.60	0.16		0.62	0.22		0.56	0.14
Phase 7	Task	3	0.50	0.13	11	0.60	0.16	3	0.47	0.12	11	0.60	0.15	3	0.66	0.16	11	0.55	0.15
	Relation		0.56	0.16		0.60	0.18		0.55	0.21		0.60	0.17		0.67	0.25		0.57	0.16

* significant at 10% / ** significant at 5% / *** significant at 1%

5. Conclusions

This research suggests two major findings. First, the contextual does matter with regards to leadership style orientation along the LEM roadmap phases, although not all variables matter to the same extent. Overall, in companies with higher levels of LM practices implementation, the contextual variable that must be mainly observed by senior managers and directors is the number of followers that both Middle Managers and Frontline Leaders are responsible for. Despite results show that this association may not always happen as expected, senior management must take into account this variable and the current phase of the lean implementation in order to better comprehend the desired behaviors of these hierarchical levels. Hence, this comprehension allows companies to plan and design the organizational structure (size of teams and hierarchy levels) according to expected outcomes for the LM implementation. Further, the identification of context's influence on leaders' style orientation helps senior management to anticipate leadership development initiatives in order to fulfill the current LEM phase requirements and outputs. Secondly, our findings support the existence of a transient leadership style orientation along the implementation of the LEM roadmap phases. Such behavioral shift is evidenced in terms of task and relation orientation and may vary according to the hierarchical level. Therefore, contrary to previous research (e.g. Dombrowski and Mielke, 2014; van Dun et al., 2016), this study provides evidence that there is not a single best leadership style for lean implementation. Actually, the best style orientation appears to be contingent and depends on the maturity of the LM implementation (LEM roadmap phase) and the respective role of the leader (Frontline Leaders and Middle Managers).

This research has some limitations. First, respondents were all from companies located in Brazil; their answers might be linked to national issues. Thus, this limitation restricts the results to this social and economic condition, indicating that diversifying the sample would help providing wider and more generalizable results. Second, the sample size effectively confirmed only the effects of some contextual variables and it was not possible to verify all variables. The influence of the variables that were not significantly associated may exist in a lower level. If that is the case, larger sample sizes can highlight those effects. Additionally, our results are limited to only three leadership contextual variables. In real case scenario, leaders are exposed to several contingency factors that may influence their behavior and the effectiveness of them during the evolutionary process of LM implementation. Third, the establishment of subsets of LM practices according to LEM roadmap phase was based on practices mainly applied within manufacturing companies. A wider comparative study among companies that are implementing the lean thinking would avoid any potential error on the assessment of practices.

Future studies could include additional variables or use multiple levels of analysis, such as systems dynamic, to capture the composed influence of those variables that were not tested at this study along time. Further, results for leadership behaviors at more advanced phases of lean implementation were not convergent. The misalignment between ideal behaviors and actual styles preferences may feature an additional opportunity for future research.

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