Lean manufacturing implementation: leadership styles and contextual variables

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Abstract

Purpose – The purpose of this paper is to understand how the association between leadership styles (task or relation orientation) and lean manufacturing (LM) implementation changes due to two contextual variables, team size and the leader's age.

Design/methodology/approach – The authors carried out a survey with 225 leaders from different Brazilian companies that are implementing LM. Research constructs were validated through rigorous procedures using confirmatory factor analysis. Hypotheses were tested using ordinary linear least squares regression.

Findings – The results suggest that larger teams and more senior managers were negatively associated with LM implementation. Task-orientation style makes leaders more likely to achieve higher levels of LM than relation-orientation style leaders. Finally, the influence of relation-oriented leaders on LM implementation is contingent upon the size of the team.

Research limitations/implications – Regarding study's limitations, sample size and respondents' location restrict results to this contextual condition, indicating that increasing the sample would help provide wider and more generalizable results. It is also worth noting that results are based on respondents' (leaders) perspective. Hence, future studies may collect data from multiple perspectives, such as leaders and their followers, in order to compare results so as to verify the convergence or divergence among different respondents.

Practical implications – The results suggest that leaders should have different behaviors according to the context in which they are inserted. Therefore, such behavioral prescriptions are useful for managers since they are pressured to achieve high operational performance in short time periods and with few resources. Further, companies undergoing lean implementation may also be able to stimulate proper leadership behaviors and promote development programs accordingly, which is extremely relevant since behavioral changes usually take time.

Originality/value – The evolutionary process for achieving a successful lean enterprise requires different leadership styles according to the context in which leaders are inserted. This research provides arguments to help better understand the recommended leadership behaviors for lean implementation, complementing existing roadmaps by considering the proper leadership style as a contingency issue during lean implementation. Moreover, identifying the effect of contextual variables helps specify the contexts in which lean practices are more likely to be implemented.

Keywords Lean manufacturing, Lean management, Leadership style, Contextual variables

Paper type Research paper

1. Introduction

In the transition from a traditional mass-production organization to a lean manufacturing (LM) enterprise, transformation in both technical and socio-cultural aspects is needed (Tortorella and Fogliatto, 2014). Since a successful LM implementation is highly dependent

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on firm employees (Sawhney and Chason, 2005), it is important to comprehend the underlying culture of LM practices (Bhasin and Burcher, 2006). In this context, leaders play a crucial role in the establishment of such lean culture (Mann, 2009; Shook, 2010).

Leadership commitment and leader's communication skills have been highlighted as key managerial attributes for successful LM implementation (Womack and Jones, 2003; Spear, 2004). In this sense, common characteristics of a lean leader are collaboration, delegation, and the ability to motivate employees (Angelis *et al.*, 2011; Pamfilie *et al.*, 2012; Dombrowski and Mielke, 2014; Gelei *et al.*, 2015). Overall, Emiliani and Stec (2005) and Suresh *et al.* (2012) suggested that lean enterprises need to have transformational leaders at the top, who behave according to expected culture and disseminate the proper lean principles.

Although leadership is a highly popular topic in academia, there are still gaps in the literature that must be addressed, in particular in companies that are implementing LM (Marodin and Saurin, 2013; Bortolotti, Boscari and Danese, 2015). Researchers also emphasize the influence of contextual variables on leadership performance, which may hinder or favor their leadership in the shift to a leaner company (Deschamps, 2005; Bäckström and Ingelsson, 2015). For instance, Castka *et al.* (2001) and Marksberry *et al.* (2010) indicated that size of the team, evidenced by the number of followers, might be an important contextual variable for determining assertive leadership styles. Parry *et al.* (2010) and Tortorella *et al.* (2017) indicated that greater leadership experience, which is closely related with leaders' age, may entail enhanced interpersonal skills that might favor the leader's choice for behaviors that more effectively support LM implementation. Thus, we argue that the identification of the contextual variables and leadership styles in an LM implementation could improve the understanding of the difficulties that companies have to implement LM. Therefore, we propose the following two research questions:

RQ1. How do different leadership styles favor LM implementation?

RQ2. How does context influence the relationship between leadership style and LM implementation?

Thus, this paper aims at identifying the relationship between leadership styles and the implementation of LM practices, as well as to analyze the moderating effect of the inherent contextual variables of leadership. We carried out a survey with 225 leaders from different Brazilian companies that are undergoing LM implementation. Respondents were asked to fill three questionnaires in the survey: the implementation level of LM practices, their leadership style and adaptability, which is defined through the application of the situational leadership (SL) questionnaire proposed by Blanchard (2010), and details about contextual variables pointed out in the literature as influential for leadership style adoption. Although previous studies (e.g. Dombrowski and Mielke, 2014; Gelei *et al.* 2015; van Dun *et al.*, 2017) have already indicated some leadership attributes and behaviors that contribute to or inhibit a successful of lean transformation, none of them have examined whether these behaviors might change according to the implementation of a specific set of LM practices. In this sense, our study bridges a gap observed in the literature regarding LM implementation, as it enables the identification of the relationship between leadership styles and implementation of different bundles of LM practices, such as just-in-time (JIT), total quality management (TQM), and total productive maintenance (TPM). Further, we investigate the moderating effect of leadership's contextual variables on such relationships, whose discussion is still scarce and shallowly approached in the LM literature (Seidel *et al.*, 2017). Since LM transformation comprises a transient process added by different contextual conditions in which leaders are inserted, this research provides arguments to better understand the recommended leadership behaviors during lean

implementation. Our research specifically focuses on two contextual variables: leaders' age, as suggested by Parry *et al.* (2010) and Tortorella *et al.* (2017); and size of the team (number of followers), according to the indications from Castka *et al.* (2001) and Marksberry *et al.* (2010). Therefore, some hypotheses are investigated in order to obtain a clearer understanding of the subject and enable a better understating over the boundary conditions that surround the problem.

2. Literature and propositions

2.1 LM

LM seeks to reduce non-value-added activities (i.e. wastes) and improve operational performance (Womack *et al.*, 1990). The literature usually defines LM as a management system formed by two levels of abstraction: principles and practices (Hines *et al.*, 2004; Shah and Ward, 2007; Pettersen, 2009). Since practices are less abstract concepts than principles, the approach of measuring the maturity of LM implementation is commonly based on the assessment of the adoption level of pre-defined practices (e.g. Shah and Ward, 2007; Netland and Ferdows, 2014; Marodin *et al.*, 2015). LM practices were developed to allow employees to solve problems at their workplace through a human-based system in which people are involved with continuous improvement initiatives (Liker, 2005).

Three bundles of LM practices are usually used to measure the level of LM implementation, JIT, TQM, and TPM (Cua *et al.*, 2001; Marodin *et al.*, 2017). JIT practices are related to the improvement of material and information flow efficiency and are composed of practices such as pull production (JIT1), takt time (JIT2), continuous flow (JIT3), material supply (JIT4), standardized work (JIT5), and production leveling (JIT6), as suggested by previous studies (Shah and Ward, 2003; Netland *et al.*, 2015). The second bundle, TPM, includes practices that are focused on creating basic stability for the production processes, as zero defects (TQM1), quality assurance (TQM2), product and process quality planning (TQM3), and problem-solving methods (TQM4), as indicated by other researchers (Shah and Ward 2007; Marodin and Saurin, 2013). Finally, the third construct, denoted as TQM, comprises practices that aim to improve and mitigate quality issues by consistently problem-solving activities, such as maintenance systems (TPM1), workplace organization (TPM2), self-management teams (TPM3), and cross-functional teams (TPM4).

Table I presents the three bundles and the practices related to each bundle, and references in the literature. Although there is some agreement on the LM bundles, there some differences on which practices are associated with each bundle. In total, 15 widely deemed papers were selected, highlighting 14 LM practices as the most cited to characterize those 3 bundles. It is worth noting that the two practices of "standardized work" and "problem-solving methods" are the most common ones. The first one appears to be applied for different motivational reasons: to create basic stability in production processes by mitigating process variability (Doolen and Hacker, 2005; Stentoft and Vagn, 2013), to balance workload among employees as observed by Shah and Ward (2007) and Bortolotti, Boscari and Danese (2015), and to emphasize quality procedures and key daily routines (Furlan *et al.*, 2011; Bhamu and Singh Sangwan, 2014). Overall, 14 LM practices that represent three constructs appeared frequently, hence, it indicates that they are a good representation to characterize a lean implementation.

2.2 Leadership styles

People have unique values and visions about how to achieve success at the individual level, and also how to manage their team to achieve their goals. As such, many leadership theories have emerged over the years to explain the complex social-technical systems that encompass the relationship between leaders and those being led. Trait theory, behavioral theories, contingency theories, and leader-member exchange theories are just some

Table I.
LM bundles, practices, and references

LM Bundle	Code	LM practices	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	Agreement (%)
Just-in-time	JIT1	Pull system	x	x		x		x	x	x	x	x	x	x		x	x	80
	JIT2	Takt time	x	x		x		x		x				x		x	x	53
	JIT3	Continuous flow	x	x		x		x	x	x	x	x	x	x		x	x	80
	JIT4	Material supply	x	x	x	x			x	x	x	x	x	x		x	x	80
	JIT8	Standardized work	x	x		x	x		x	x	x	x	x	x	x	x	x	87
	JIT9	Production leveling	x			x	x	x	x	x	x	x	x	x		x	x	80
Total quality management	TQM1	Zero defects	x	x			x	x	x	x	x	x				x	x	67
	TQM2	Quality assurance	x	x	x	x				x	x	x				x	x	60
	TQM3	Product/Process quality planning	x		x	x	x			x	x	x		x		x	x	67
	TQM4	Problem-solving methods	x		x		x	x	x	x	x	x	x	x	x	x	x	87
Total productive maintenance	TPM1	Maintenance system	x	x		x		x	x	x	x	x	x	x		x	x	80
	TPM2	Workplace organization	x	x					x	x	x	x	x	x	x	x	x	73
	TPM3	Self-managed teams	x					x	x			x	x		x	x	x	53
	TPM4	Cross-functional teams		x		x	x					x	x			x		40

Notes: 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, Boscari and Danese (2015); Bortolotti, Danese, Flynn and Romano (2015); (14) Netland *et al.* (2015); (15) Marodin *et al.* (2015)

examples of leadership theories. Each one presents a different perspective about how leaders influence the team (Robbins and Judge, 2011). The contingency theory model of leadership effectiveness was based on Fiedler (1978). It has been the basis for an extensive body of research, with numerous studies supporting its propositions. Tannenbaum and Schmidt (1973), for example, proposed a model focused on the extent to which decision making is centralized in a group of employees vs totally made by the leaders. For example, some leaders may have a dominant role in the decision making, while others may allow the group to make decisions by themselves, within prescribed limits.

Effective leaders demonstrate a balanced arrangement of multiple styles, according to van Eeden *et al.* (2008). Avolio (2011) highlighted the significance of harmonizing three leadership styles: laissez-faire, transactional, and transformational. Such styles might be placed on a continuum where the least people-concerned style is laissez-faire; transactional leadership encompasses the rationale of encouraging rewards and benefits to subordinates in order to get their cooperation; and transformational leadership builds commitment to support employees achieving their goals.

Overall, Hersey and Blanchard's (1969) and Hersey *et al.*'s (2001) SL model is one of the best-known leadership characterization models (Yukl, 2006; Papworth *et al.*, 2009). SL is based on three leadership dimensions, two of which are 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 in four different styles. The first style, "S1," presupposes low leadership emphasis on relationships and high focus on tasks. The second leadership style "S2," characterized as an explaining, selling, or persuading places high emphasis on both tasks and relationships. The third leadership style (S3) denotes a leader who encourages, participates, or supports problem solving, and, hence, is mainly focused on relationship behavior and places a low emphasis on task accomplishment. Finally, S4 (low R, low T) is characterized as an observing, delegating, or monitoring leadership style.

Additional studies have extended the discussion about effective leadership styles. Sethuraman and Suresh (2014) expanded the understanding of SL theory by investigating the influence of leader personality types on leadership behavior through the application of Myers Briggs' Type Indicator. Also, Thompson and Glaso (2015) aimed to quantify the followers' needs from three perspectives: measuring followers' competence; examining the leader-follower dynamic along a continuum of job levels; and comparing the degree of self-other agreement in follower competence and commitment ratings to identify whether a higher correlation more adequately validates the SL model. Furthermore, Pasaribu (2015) explored the impact of SL behavior, organizational culture, and human resources management strategies on productivity.

Criticism of the SL model among scholars (Vecchio *et al.*, 2006; Vroom and Jago, 2007; Thompson and Vecchio, 2009) contrasts with the model's popularity among practitioners (Avery and Ryan, 2002; Chen and Silverthorne, 2005; Bates, 2014; Jain and Chaudhary, 2014), who report its application as a supporting tool to assess leadership styles. In this sense, due to its ease of application and broad practical acceptance, we propose the utilization of SL theory in this study. Moreover, previous studies on LM implementation and leadership (e.g. van Dun *et al.*, 2017; Tortorella and Fogliatto, 2017, Tortorella *et al.*, 2017) have applied such theory in order to support their investigations.

2.3 Leadership contextual variables

Contingency theory argues that the successful implementation of any operations management practices depends upon organizational characteristics (Lawrence and Lorsch, 1986). Moreover, there is not a fixed recipe for success, since every organization

starts with a different set of variables and constraints (Sousa and Voss, 2008). The understanding of the current context in which leaders are inserted is fundamental for driving appropriate behaviors (Achanga *et al.*, 2006). Contextual variables represent situational characteristics usually exogenous to the organization or leader, and the opportunity to control these variables is limited (Anand and Kodali, 2008). In this regard, Yukl (2006) and Thompson and Vecchio (2009) stated that leadership effectiveness is dependent on a leader's behaviors, which is affected by situational aspects that enable a leader to influence his/her followers (Maj, 2011).

Several empirical studies suggest that leadership style effectiveness is contingent upon specific contextual characteristics (Sim and Rogers, 2009; Heldal and Antonsen, 2014). For instance, Kay Brazier (2005) investigated the influence of contextual factors, such as organizational structure and work group collectivism, on leadership behaviors. More specifically, Shalley and Gilson (2004) examined the role of leaders and human resource practices for developing contextual conditions that are supportive of employees' creativity, categorizing such contextual factors into four levels: individual, job, team, and organization. Cogliser and Schriesheim (2000) examined the contextual factors of team size, team cohesiveness, and organizational climate for their relationship with leader-member exchange from the subordinate's perspective. Their findings show that a team's contextual factors are related to leader-member exchange. Unfortunately, the limitations of the cross-sectional study preclude making any inferences about the directionality of the relationship.

Overall, the current leadership debate has placed too much emphasis on the leadership behaviors and styles, and too little on the need for understanding the complex contexts in which this leadership takes place (Smith *et al.*, 2004). Further, a theory that is developed in one context may not be transferable to another context, particularly where there are different characteristics (Spangler, 2015). Therefore, although some researchers developed their theories following extensive study within a single organization, any theory of leadership should be evaluated in different contextual factors so results can be generalized (Kay Brazier, 2005).

2.4 LM practices implementation and leadership styles

LM practices implementation enhances the application of workforce skills by empowering and involving workers, integrating direct and indirect work, and encouraging continuous improvement activities. Such implementation generates expectations regarding leadership's behaviors (House *et al.*, 2004), which are understood to be specific and observable verbal and non-verbal actions of leaders when interacting with their subordinates (Szabo *et al.*, 2001). In this sense, Mann (2009) reinforced that 20 percent of the effort in an LM transformation is related to the implementation of practices and tools, while 80 percent focuses on changing leaders' behaviors. Further, according to Dombrowski and Mielke (2014), the way leaders behave influences the attitudes and behaviors of the subordinates, thereby modeling the culture within the organization undergoing an LM implementation.

van Dun *et al.* (2017) observed that both leadership orientations (task and relation) are present as characteristics of lean leaders. In turn, Gelei *et al.* (2015) investigated the main attributes of lean leaders, which have also been emphasized by Dombrowski and Mielke (2014). Complementarily, Tortorella and Fogliatto (2017) investigated the styles of leaders from different hierarchical levels of an organization undergoing a certain implementation phase of the LM roadmap. Overall, existing studies verify the relationship between leadership and LM implementation from a narrow or short-sighted approach, and only indicate certain trends based on few case studies, without empirically testing and validating such associations. However, many studies (e.g. Liker and Convis, 2011; van Dun *et al.*, 2016) indicate that effective lean leaders are more likely to spend a significant amount of time in

communication and problem-solving orientations, which are typical relation-oriented behaviors. In turn, autocratic behaviors complemented by low levels of employee involvement arguably undermine the establishment of a culture of continuous improvement (Womack and Jones, 2003; Bortolotti, Boscari and Danese, 2015). Thus, to examine the effect of leadership style on the implementation of LM practices, we formulate the following hypotheses:

H1a. Task-oriented leaders have a negative influence on LM implementation.

H1b. Relation-orientated leaders have a positive influence on LM implementation.

2.5 LM practices, leadership styles, and contextual variables

The contingency approach assumes that contextual variables, in the long-term, influence the leadership behavioral responses during the implementation of LM practices (Desai, 2011; Gelei *et al.*, 2015). In this study, we examine two leadership contextual variables that may influence the effect of leadership style on the implementation of LM practices: leaders' age (LA) and size of the team (ST) or number of subordinates. While both variables have been independently studied previously within leadership literature (Avery and Ryan, 2002; House *et al.*, 2004), their influence on the relationship between leadership styles and LM practices is comparatively unexplored. There is not only a lack of empirical attention given to the relationship of contextual factors with leadership styles, but there is also a paucity of theory to guide our expectations about the direction of possible effects on LM practices implementation (Marksberry and Hughes, 2011; Liker and Convis, 2011).

Regarding the contextual variable LA, leaders are assumed to have experience, entailing a high level of tacit knowledge that leads to more assertive actions and behaviors, especially in situations involving conflict (Hunt and Baruch, 2003; Pasaribu, 2015). Besides leadership experience, previous studies have associated the leader's maturity with the leader's age, due to the fact that it may influence the accrued experience and, the likelihood of presenting effective interpersonal skills (Parry *et al.*, 2010; Dombrowski and Mielke, 2014). Therefore, the literature empirically suggests that leadership effectiveness is positively influenced by the age of the leader, since it may allow leaders to become more aware and to adapt their style during lean implementation. Accordingly, we propose the following hypothesis with regard to LA, leadership styles, and implementation of LM practices:

H2. Leader's maturity positively moderates the effect of leadership styles on the LM implementation.

Further, team size may also influence the leader's ability to properly manage and adapt his or her style to the maturity level of various followers. Researchers have shown that leaders have many important roles, such as responding to Andon pulls, auditing standardized work, facilitating problem solving within teams, and job instruction training (Gupta *et al.*, 2000; Liker and Convis, 2011). Moreover, with regard to interpersonal relationships, leaders have been key in establishing trust among followers and instrumental in teaching and developing them (Hall, 2006). In this sense, empirical evidence suggests that the larger the size of the team, the more complex the implementation of any change process (Castka *et al.*, 2001; Gelei *et al.*, 2015). Toyota's team leaders, for instance, have been widely studied and benchmarked, and have become an influential factor in designing effective work group leaders. Generally, each Toyota's team leader is supposed to have from four to six subordinates (Marksberry *et al.*, 2010). Accordingly, the size of the team may influence both time allocation for coaching activities and the likelihood of properly matching the leadership style to an individual's maturity level. However, certain previous studies on leadership (e.g. Cogliser and Schriesheim, 2000) did not prove statistically the hypothesis that team size was negatively related to assertive leadership behaviors, although the trend was in

this direction. Thus, the net effect of ST on the relationship between leadership styles and implementation of LM practices is an empirical question, which we propose to test as follows:

H3. Larger teams negatively moderate the effect of leadership styles on the LM implementation.

The proposed framework comprised in this research is displayed in Figure 1. According to the figure, we propose two direct effects: task- and relation-oriented leadership styles that influence LM implementation; and the moderating effects of two variables in this relationship: leader's age and team size.

3. Method

3.1 Sample selection and characteristics

A recent study from Kull *et al.* (2014) suggests that national culture could influence the implementation of lean practices. Therefore, a single geographic location also increases the homogeneity of the sample. Therefore, aiming to reduce the effects of the external environment (e.g. regional culture, and socio-economic development) that can affect the leadership style in LM, we limited our sample only to leaders from companies located in a specific region: Southern Brazil. Moreover, the respondents should have experience in LM and a leadership role in the company, e.g. general manager, assistant manager, group leader, and team leader (Liker and David, 2004). Regarding industry characteristics, our sample included companies from different industrial sectors because of the limited number of companies in this country adopting LM practices, as is commonly the case in emerging economies (Marodin *et al.*, 2016). Additionally, although implementing LM is usually associated primarily with high volume and discrete part manufacturers, the pervasiveness of practices across the industrial spectrum is unknown (Tortorella *et al.*, 2015), which further justifies our cross-industry sample. The non-random choice of companies for surveys and the search for companies is a commonly used strategy in other studies on LM given the criteria in question (Shah and Ward 2007; Saurin *et al.*, 2010; Boyle *et al.*, 2011).

Questionnaires were sent by e-mail to 387 leaders who 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 percent). The conference was held by the Industrial Engineering Department of a large Brazilian University. The institution also offers short, executive courses on LM, and the department is

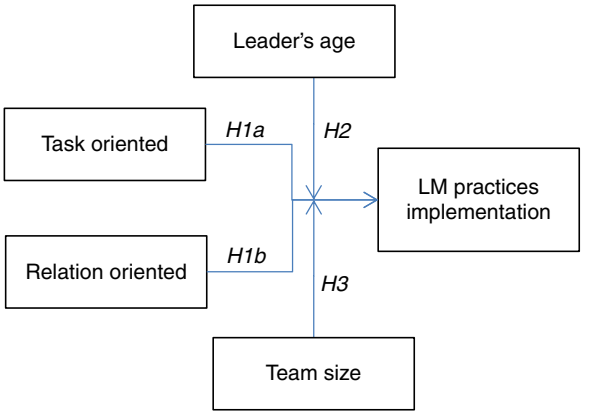

Figure 1.
Proposed theoretical framework

widely recognized for its research and academic-industry interaction in the operations management field. The same questionnaire was also used in a previous research project, published at Tortorella *et al.* (2017).

When comparing the industry distribution of the samples (Table AI) with the percentage of a Brazilian national industrial transformation index (FIESC, 2015), only two segments were not significantly different. The sample had 19 percent of respondents from the chemical industry, the national value of which was around 10 percent, and 8 percent of respondents were from the fabric and cloth industry, which had a national industry transformation index classification in Brazil of around 18 percent. Both of these differences were not considered to be problematic, and reflect the regional characteristics of southern Brazil (FEE, 2016, FIESC, 2015).

We tested the possible non-response bias using Armstrong and Overton's (1977) procedure. Thus, we evaluated the differences in means between the early (respondents to the first e-mail sent; $n_1 = 63$) and the late (respondents to the two follow-ups; $n_2 = 162$) respondents using Levene's test for equality of variances and a *t*-test for the equality of means. These results showed significance levels higher than 0.05, which suggests that the groups did not have different means and variances and, consequently, there is no statistical evidence that our sample is significantly different from the rest of the population (Armstrong and Overton, 1977). It is noteworthy that countermeasures have been addressed to avoid duplicates in sample responses.

The sample presents a balanced amount of companies for each contextual variable. Most respondents were from large companies; a large number of companies belonged to metal products, equipment, automotive, and metallurgy industries (45 percent). Most respondents (61 percent) had up to two years of leadership experience, and were more than 30 years old (52 percent). Further, most respondents were male (68 percent), and directly lead teams that comprised five or more subordinates (52 percent). Finally, the position held was well balanced among general managers, assistant managers, group, and team leaders. The sample demographic characteristics are detailed in Table AI.

3.2 Measurement

The questionnaire was structured in three main parts: demographic information of the respondents and their companies; conditional items – the leader's age and team size; and control variables, such as company size and industry. The items regarding LA, ST, and company size were categorized into two levels. For LA, the respondents were asked to tell us if their experience in LM projects was longer or shorter than two years; ST responses were according to a number of subordinates of equal to or lower than five, and more than five subordinates; and companies were characterized between large (more than 500 employees) or medium and small (less than 500 employees).

The second part of the questionnaire assessed the respondents' leadership style. We adapted the Leadership Effectiveness and Adaptability Description (LEAD) model originally developed by Hersey and Blanchard (1969) and improved by Blanchard (2010). We adapted it to be used in an organizational environment undergoing lean implementation. The LEAD model exposes respondents to different workplace situations and asks for answers that describe how they would react to specific situations. The objective was to determine how leaders behave as well as their propensity to adapt their leadership style to different subordinates' readiness. Several references report the application of LEAD as a supporting tool to assess task- and relation-orientated leadership styles (e.g. Blanchard *et al.*, 1985; Chen and Silverthorne, 2005; Bates, 2014). The questionnaire consisted of 12 questions related to leadership behaviors, aiming to identify the primary (adopted most frequently) and secondary (adopted as backup) leadership styles, as well as the leader's adaptability level to different styles.

Finally, the third part of the questionnaire aimed at measuring the degree of adoption of the 14 LM practices described in the literature (Table I). The degree of adoption was measured on a five-point Likert scale ranging from 1 (not used) to 5 (fully adopted). In this sense, a similar header to the one presented by Shah and Ward (2003) was used, which stated, "Please indicate the extent of implementation of each of the following practices in your plant."

3.3 Common method variance

Several procedures were performed to reduce common method variance based on Podsakoff's *et al.* (2003) recommendations, both for procedural and statistical remedies. As procedural remedies, we: randomized the questionnaire items to avoid the associations between items representing the same construct; considered only key respondents, since we limited our sample only to LM leaders; included a statement at the beginning of the questionnaire reinforcing the idea that there was no right answer; and reviewed the wording and format of questions to assure correct understanding. Also, since the LEAD instrument is an ipsative questionnaire with possible qualitative answers, and not based on scales, the respondents could intentionally associate independent and dependent variables when answering the questionnaire. Thus, we believe that the questionnaire is avoiding common method variance, according to Podsakoff *et al.* (2003).

As statistical remedies, we performed the Harman's single factor test which is based on a principal component analysis (PCA), and performed a single-method-factor approach, which is referred to by Malhotra *et al.* (2006) as a *post hoc* marker variable analysis. Harman's test suggests that when most of the variables load into a single factor, which accounts for the majority of the variance, common method variance is a problem. We obtained six components with a PCA, including all the variables used in the study, and the first factor represented only 18.14 percent of the variance, indicating that common method variance might not be a concern in the sample. Then, we followed the single-method-factor approach procedure as suggested by Podsakoff *et al.* (2003, 2012), wherein the source of bias is not identified a priori. This method consists of including a single common method variance factor and evaluating the changes of the coefficients of each item in the model. We performed a confirmatory factor analysis (CFA) analysis of the three constructs (JIT, TPM, and TQM) and their respective items, with and without the inclusion of the single common factor. The difference between the two models was below 0.021 for all items, and below the 0.2 threshold for the coefficient differences, as suggested by Doluca *et al.* (2017). The procedural and statistical remedies used indicate that common method variance is not a concern in our research.

3.4 Construct validity and reliability

CFA was used to assure convergent validity and unidimensionality of the three constructs that had multiple items (JIT, TQM and TPM). First, the three CFA models were estimated, one for each construct. All factor loadings were higher than the threshold value of 0.5, which was above the limits suggested by Hair *et al.* (2006) for our sample size. Second, each CFA model was re-assessed and the results indicated an adequate fitness of the models using a χ^2 test (χ^2/df), comparative fit index (CFI), and standardized root mean squared residual (SRMR), as presented in Table II. As thresholds, we used values greater than 0.95 of the CFI, combined with values of the SRMR greater than 0.09, so minimizing the sum of error rates of types I and II of the CFA model, as suggested by Hu and Bentler (1999) for sample sizes lower than 250 observations. For reliability purposes, Cronbach's α of each construct was also calculated and, in all cases, values were greater than 0.7, indicating satisfactory validity for all constructs (Nunnally and Bernstein, 1978; Hair *et al.*, 2006). The final values for the validated constructs were obtained using the factor loadings of the questionnaire items that represent each construct.

Construct		LM practices	Coefficient	Correlations JIT	TQM	TPM
JIT	JIT1	Pull system	0.675	–	0.666***	0.679***
	JIT2	Takt time	0.794			
	JIT3	Continuous flow	0.833			
	JIT4	Material supply	0.698			
	JIT8	Standardized work	0.690			
	JIT9	Production leveling	0.738			
TQM	TQM1	Zero defects	0.533	0.666***	–	0.711***
	TQM2	Quality assurance	0.775			
	TQM3	Product/Process quality planning	0.798			
	TQM4	Problem-solving methods	0.774			
TPM	TPM1	Maintenance system	0.610	0.679***	0.711***	–
	TPM2	Workplace organization	0.642			
	TPM3	Self-managed teams	0.812			
	TPM4	Cross-functional teams	0.720			
	χ^2			35.266	6.054	12.181
	df			9	2	2
	CFI			0.958	0.987	0.961
	SRMR			0.036	0.022	0.036
	Cronbach's α		0.848	0.725	0.800	

Notes: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table II. Lean manufacturing constructs, questionnaire items, and CFA factor loadings

3.5 Moderators and control variables

The items regarding task and relation leadership styles from LEAD's questionnaire provide a scale from 0 to 12. We standardized each respondent' score for the two LSs, task and relation, as recommended by Baron and Kenny (1986) for predictors used when testing moderation effects. This procedure aims to address multicollinearity problems (Aiken and West 1996). LA and ST variables were not standardized because they were dichotomic. Then, we calculated the interaction terms (task × LA, relation × LA, task × ST, and relation × ST). We reported the results as unstandardized coefficients since the scales were standardized prior to the analysis (Goldsby *et al.*, 2013).

We have also considered company size as a control variable, since large companies are more likely to implement LM (Shah and Ward, 2003; Tortorella *et al.*, 2015; Marodin *et al.*, 2016). A dummy variable was used for large companies (500 or more employees) and small- and medium-size companies (less than 500 employees), following a commonly used company size classification for Brazilian firms (Marodin *et al.*, 2016). It is worth noting that we also tested all models with dummy variables for industry type (Sector in Table AI), as process considerations and external contingencies related to industry sector may explain the degree of LM implementation. Nevertheless, all six industry type dummies were not significant and results hold when those variables were excluded from the regression models. As such, we preferred to show the results without those control variables, as it slightly increases the degrees of freedom and significance of our tests.

4. Results

A set of ordinary least square (OLS) hierarchical linear regression models were performed to test both theoretical models proposed. Table III presents the regression models with LM bundles of JIT, TPM, and TQM as dependent variables. Model 1 shows the control variable of company size, and task and relation orientation as independent variables. Model 2 also incorporates contextual variables LA and ST as predictors. We included the moderation

Table III.
Results of OLS regression analysis for the implementation of constructs of LM practices

	JIT			TPM			TQM		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Size	*0.598***	*0.356***	*0.322***	*0.609***	*0.403***	*0.388***	*0.695***	*0.476***	*0.427***
Task	*0.106**	*0.157***	0.110	*0.124**	*0.155***	*0.205**	0.052	0.080	0.064
Relation	*−0.323***	*−0.269***	*−0.253***	*−0.153***	*−0.131***	−0.127	*−0.158***	*−0.143***	−0.001
ST		−0.051	−0.063		*−0.369***	*−0.376***		*−0.526***	*−0.532***
LA		*−1.018***	*−1.012***		*−0.707***	*−0.704***		*−0.687***	*−0.667***
Task × LA			−0.012			−0.167			0.060
Relation × LA			*0.172**			*0.205**			0.121
Task × ST			0.070			−0.142			−0.053
Relation × ST			−0.136			0.064			*−0.293***
F	18.618***	34.585***	19.644***	11.335***	18.240***	10.767***	13.097**	22.981***	13.938**
Adj. R^2	0.192	0.430	0.429	0.122	0.279	0.283	0.140	0.330	0.343
R^2 change		0.238***	-0.001		0.157***	0.004		0.190***	0.013*

Notes: *,**,***Significant at the 10, 5 and 1 percent levels, respectively

effects in Model 3. The variance inflation factors in the regression models were all < 4.0, suggesting that multicollinearity was not a concern.

Model 1 was significant for JIT (adjusted $R^2 = 19.2$ percent, p-value < 0.01), TPM (adjusted $R^2 = 12.2$ percent, p-value < 0.01), and TQM (adjusted $R^2 = 14.0$ percent, p-value < 0.05). Model 2, which includes LA and ST, significantly improves the performance of prediction (adjusted R^2) of JIT, TPM, and TQM constructs, as p-value of R^2 change < 0.01. Model 3 includes the moderator effects of ST and LA on the relationship between leadership styles orientation and LM practices implementation. Only the TQM construct had a significant incremental improvement of the model prediction capacity (p-value of R^2 change < 0.05). Overall, all models significantly described JIT, TPM, and TQM implementation. However, the moderation effect included in Model 3 only improved the prediction capacity (adjusted R^2) of TQM; hence, Model 2 best describes JIT and TPM implementation.

Therefore, our results pointed out that task-oriented leaders are positively associated with JIT and TPM practices, as Model 2 demonstrates for those constructs. Also, relation-oriented behaviors had a negative impact on those same JIT and TPM constructs. Although these results were interesting, we reject *H1a* and *H1b*, because our hypothesis was exactly the opposite, contradicting the current literature.

We did not find empirical evidence to support *H2*. LA interactions with task and relation were not significant on Model 3. Nevertheless, *H3* is partially supported as we found empirical evidence that relation-oriented leaders with larger teams (more than five subordinates) are likely to present a negative association ($\beta = -0.293$; $p < 0.05$) with TQM implementation, which is an interesting outcome and merits further discussion. It is worth noting that ST (i.e. having more than five subordinates) was negatively associated with TPM and TQM, and LA (i.e. being older than 30 years) was negatively associated with all LM bundles.

Assumptions of normality, linearity, and homoscedasticity were tested between independent variables (focal predictor and moderator) and the different dependent variables (JIT, TPM, and TQM) (Hair *et al.*, 2006). We examined the residuals to confirm normality of the error term distribution. Linearity was tested with plots of partial regression for each model. All regression models performed did not present evidence to reject the hypothesis of adherence to the normal distribution (Kolmogorov-Smirnov test p-value > 0.05) of residuals. Finally, we evaluated homoscedasticity by plotting standardized residuals against predicted value and examining visually. These tests confirmed the three assumptions for OLS regression analysis.

5. Discussion

We investigated the relationship between the implementation of LM practices and leadership styles orientation, and the moderator effect of the leadership contextual variables. LM practices are widely disseminated as a way to improve operational performance, such as reducing inventory and costs, increasing quality and delivery service levels, etc. Although LM practices involve a set of technical propositions, they are not fully adopted unless the socio-cultural aspects (behaviors and organizational culture) of the lean change are also addressed during the implementation. Thus, leaders are essential to demonstrate and define the expected behaviors in order to address socio-cultural issues that might undermine the LM implementation (Mann, 2009; Liker and Convis, 2011). The specialized literature on LM frequently states that leaders in companies undergoing lean implementation must be collaborative, delegators, and excellent motivators of their subordinates. However, the literature has not yet considered detailed descriptions of attributes and styles of leadership desirable to support the evolution of lean implementation. Further, previous studies (Dombrowski and Mielke, 2014; Gelei *et al.*, 2015) which investigated leadership attributes that contribute to (or inhibit) a successful lean implementation perform a *post hoc* analysis focusing on high maturity companies such as

Toyota, and disregard the evolutionary nature of the implementation process and its resulting demands for adaptive and transient leadership attributes and styles. Through an empirical survey with 225 leaders from different companies, we explored the moderating effect of leadership contextual variables (LA and ST) on the relationship between implementation of LM practices (JIT, TPM, and TQM) and leadership style orientation (task and relation).

Our results indicated that leadership style orientation was associated with the implementation of JIT and TPM bundles of LM. However, the effect of these relationships is contrary to what has been proposed in *H1a* and *H1b*. Leaders who are relation oriented have a negative association with JIT and TPM, while task-oriented leaders are positively related. These results emphasize the importance of leadership task orientation and are somewhat coherent with previous indications from Spear and Bowen (1999) and Spear (2004, 2009), which suggest that LM practices drive highly specified activities as to content, sequence, timing, and outcome, usually developed under the guidance of a senior leader, at the lowest possible level in the organization. Further, this style is also marked by efforts to establish well-defined patterns of organization and channels of communication (Thompson and Vecchio, 2009), corroborating our findings. This outcome might feature a unique behavior for a specific condition related to LM implementation. In turn, an increase in leaders' relation orientation seems to undermine the implementation of these practices. In fact, highly relation-oriented leaders tend to be delegators and facilitators which, depending on their subordinates' maturity, may not be effective. Specifically, for JIT, some authors (e.g. Rother and Harris, 2001; Duggan, 2012) indicate that these practices should be the last to be implemented in an LM transformation, since basic stability must be properly in place to guarantee an effective flow of value. Therefore, it is reasonable to expect that most companies' comprehension on these practices would be limited, justifying why this kind of leadership may be harmful for JIT implementation.

H2 and *H3* included the moderator effect of leadership context. Each of the contextual variables studied is associated with a significant lore about their effect on the relationship between leadership style orientation and LM practices implementation. The literature supports the idea that experienced leaders are more likely to present appropriate behaviors under different conflict situations. Our findings expand this discussion. In fact, they suggest that the impact of LA is direct, not a moderation. In other words, our results emphasize the importance of LA as a contextual variable for all practice implementation, and it does not seem to moderate the relationship between them and leadership behaviors. Further, our findings indicate that younger leaders are more likely to be successful in LM implementation than older ones. This result is somewhat surprising in light of conventional wisdom about the difficulty of implementing any management practices without a minimum level of accrued experience and interpersonal skills to deal with the change process. However, such an outcome can be justified due to the still incipient LM implementation in emerging countries, such as Brazil, whose cross-industry dissemination of LM is less mature than in developed economies (Saurin *et al.*, 2010; Marodin *et al.*, 2016). Therefore, older, and hence more experienced leaders, who have already settled a way of working with their subordinates, might struggle with the insertion of practices and underlying behaviors necessary for a successful and long-term LM implementation. In opposition, younger leaders, who are usually still developing their skills and ways of working, are more likely to favor and support LM implementation.

With regards to ST, the moderation effect was only significant for TQM, although our results also indicate the existence of direct effects of ST on JIT and TQM. ST is usually considered as an output of the characteristics of organizational structure and strategy (Cogliser and Schriesheim, 2000; Castka *et al.*, 2001, Vera and Crossan, 2004). Our results suggest that larger teams may impair both JIT and TQM implementation, while negatively

moderating the relationship between leaders whose primary style is relation oriented and TQM, so partially supporting *H3*. The conventional wisdom associated with ST is that it is encumbering and that leaders with larger teams are less likely to exhibit an effective behavior that properly matches the maturity of each follower. Such a gap is considerably reinforced if the leader develops relation-oriented behaviors. Managerial studies (Szabo *et al.*, 2001; Chen and Silverthorne, 2005; Howell and Shamir, 2005) affirm that leaders with large teams tend to choose a single leadership style (task orientation), regardless of their subordinates' maturity. This finding is particularly interesting due to the fact that it is related to TQM practices. Previous studies highlight that practices aiming at improving quality are extremely human related (Cox and Chicksand, 2005; Ismail Salaheldin, 2009) and, hence, leadership effectiveness should be taken into account as a matter of course. Therefore, comprehending the effect of ST on the relationship between leadership styles orientation and TQM practices implementation presents a differentiated importance, and may help leaders conduct more assertive behaviors.

6. Conclusions

The current research was conducted assessing leaders of Brazilian manufacturing companies, but our findings may apply to a wider population. Our results showed that a relation-oriented leadership style can be negative for the implementation of LM practices, and this is even worsened when leaders have larger teams, which was specifically observed for TQM. On the other hand, we identified that older leaders may struggle with LM implementation, and its impact is direct. Regarding task-oriented leaders, we verified that its effect is positive for most practices, but no moderation effect was found for this style orientation. Implications of these results are of considerable importance and relevance for both researchers and lean practitioners.

6.1 Implications for theory

From a theoretical perspective, our results provide additional evidence supporting the significance of understanding the contextual factors involved in the relationship between LM practices implementation and leadership styles (Gelei *et al.*, 2015). However, this relationship, and the contextual variables that surround it, have only been theorized (e.g. Mann, 2009; Liker and Convis, 2011; Dombrowski and Mielke, 2014, van Dun *et al.*, 2017), and not tested before. This research is a starting point to fill that gap in the literature, as we focus only on the relationships between LM practices and leadership styles orientation, considering the effect of the context. Nevertheless, our results show that there are associations between leadership context and styles orientation in LM practices implementation.

In fact, high task-oriented leaders are significantly positively associated with the implementation of LM, while high relation-oriented leaders are significantly negatively associated with the implementation of LM. However, when leadership contextual variables are included, results indicate that the context does matter with regard to leadership behaviors and their relationship with the implementation of LM practices, although not all aspects matter to the same extent and it depends on the set of practices being implemented (JIT, TPM, and TQM). Moreover, some results demonstrate that, although literature indicates a certain level of influence, the moderator role of contextual variables' may present contrary effects to those expected.

6.2 Implications for practice

Some managerial contributions must be highlighted. Our results suggest that leaders should have different behaviors according to the context in which they are inserted. In sum,

younger, task-oriented style leaders who are working with small teams seems to be achieving a higher level of LM implementation than more senior, relation-oriented leaders or leaders with a high number of subordinates. Nevertheless, for areas where relation-oriented style leaders are in charge, smaller team size would be beneficial for them, as the moderating effect was significant.

Such a finding might be justified by the socio-economic aspects that surround the study (Brazilian companies), which entail a far more incipient dissemination of LM implementation than in developed economies, such as the USA and Europe (Marodin *et al.*, 2016). Overall, task-oriented behaviors appear to be positively contributing to LM practices, suggesting the importance of the high level of work specification and definition. These prescriptions of how leaders should behave when implementing LM practices is extremely useful for managers since they are pressured to achieve high operational performance in short time periods and with few resources.

Analyzing these results, companies undergoing lean implementation may also be able to set in place and stimulate proper leadership behaviors and promote leadership development programs accordingly. It is also worth noting that this study outlines leadership style preferences according to different contextual variables in companies undergoing lean implementation. The establishment and utilization of such behavioral preferences allow companies to verify and compare changes in leaders' styles, fomenting the development of leaders with characteristics that foster a wider implementation of LM practices. This is extremely relevant since changes in leadership behaviors usually take time. It is thus important to understand existing opportunities and have a clear vision of current gaps within a company. Envisioning the desirable leadership styles in specific contexts may help companies to design their lean transformation viewing the behavioral change in leadership as a transient process toward a lean enterprise.

6.3 Limitations and future research

Some limitations must be highlighted due to the nature of the sample used in the survey. First, the respondents were mostly from companies located in Southern Brazil; their answers might be linked to regional issues, where the spread of LM may have come under local influences. Thus, this limitation restricts the results to this contextual condition, indicating that increasing the sample would help provide wider and more generalizable results. It is worth noting that companies in other countries and regions may experience the same contextual conditions. Second, the sample size effectively confirmed only some moderator effects of the contextual variables, and it was not possible to reject all null hypotheses proposed. The hypotheses that were not rejected may exist at a lower level. If that is the case, larger sample sizes can highlight those effects. Nevertheless, the exploratory nature of this research provided important evidence for developing more structured models that should be tested empirically. Third, the companies' different experiences in LM may also represent a limitation for the sample. This fact may influence the respondents' perception of the LM practices implementation, since their mental models may be in different evolutionary stages. Thus, a comparative study among companies that are implementing the same lean phase would avoid any potential error in the collected data. However, it is important to mention that, even in the same company, there may exist departments with different levels of LM experience which can affect data collection. Finally, since the LEAD instrument is an ipsative questionnaire to indicate a specific type of measure in which respondents compare desirable options and pick the one that is most preferred, questions needed to be answered from the individual respondent's perspective, so the end result (the leader's behavioral style) could be assertive. Future studies may collect data from multiple perspectives, such as leaders and subordinates, in order to compare results so as to verify the convergence or divergence among different respondents.

Therefore, further research opportunities may be well planned and designed in order to avoid such potential issues. Additionally, our results are limited to only two contextual variables. In real case scenarios, leaders are exposed to several contingency factors that may influence their behavior and the relative effectiveness thereof during the evolutionary process of LM implementation. Future studies could include additional variables or use multiple levels of analysis, such as dynamics systems, to capture the joint influence of those variables that were not tested in this study along time. Furthermore, it was not possible to identify in the survey sample of respondents those who would qualify as authentic leaders. According to Avolio *et al.* (2004), authentic leaders are individuals who are deeply aware of how they think and behave, and are perceived by others as being aware of their own and others' values/moral perspective, knowledge, and strengths. The identification of such leaders was beyond the scope of this study but is viewed as a promising future research topic. Regarding the proposed objective, this investigation identifies the relationship between the implementation of LM practices and leadership styles orientation, and the moderator effect that the leadership contextual variable presents. Due to poor evidence in the literature on the likelihood of any interdependent influence, further sampling of companies would be required to establish a more general perspective about the problem. Such an extension would require a more elaborate data collection and analysis.

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Appendix

	Percentage
Company size	
Small	10
Medium	18
Large	72
Sector	
Metal products, equipment, automotive, and metallurgy	45
Chemicals (e.g. plastic, rubber, and others)	19
Tobacco	15
Fabric and Cloths	8
Food	7
Services	6
Other	7
Leaders' age	
Equal or less than 30 years old	48
More than 30 years old	52
Leaders' gender	
Male	68
Female	32
Size of team (directly subordinated)	
Equal or less than 5 followers	52
More than 5 followers	48
Leadership experience	
Equal or less than 2 years	61
More than 2 years	39
Job title	
General manager	20
Assistant manager	23
Group leader	30
Team leader	27

Table AI.
Sample characteristics

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