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Analyzing the influence of organizational culture and leadership styles on the implementation of lean manufacturing

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Abstract

This paper aims at identifying the combination of organizational culture profiles and leadership styles that best support companies implementing lean manufacturing practices. For that, 225 leaders from manufacturing companies at various stages of lean implementation were surveyed. The analytical approach clustered respondents and their respective firms according to prevailing organizational culture, leadership style and level of implementation of lean practices, testing for frequency differences among clusters. This study states that organizational culture profiles are related to leadership styles and lean manufacturing implementation level, suggesting different-from-expected effects of this relationship on lean manufacturing implementation. The study bridges a gap in the literature by exploring how the association between organizational culture and leadership styles occurs in companies that are adopting lean practices.

Keywords: Lean manufacturing, Leadership, Organizational culture, Multivariate data analysis.

1. Introduction

Effective implementation of lean manufacturing (LM) depends upon people, both leaders and followers, regardless of the kind of organization in which it takes place (Sawhney and Chason, 2005; Grigg et al., 2018). LM is deemed to be grounded on principles such as 'continuous improvement' and 'respect for people' (Toyota, 2001; Emiliani and Stec, 2005; Dinis-Carvalho, 2020). 'Continuous improvement' encompasses practices that aim at enhancing quality and productivity (Ohno, 1988). 'Respect for people' is comprised of organizational and leadership characteristics that need to be aligned with waste elimination and value-added creation (Treville and Antonakis, 2006). Hence, moving from a mass production model to a LM system calls for significant changes on both technical and socio-cultural aspects (Tortorella and Fogliatto,

2014), requiring proper organizational culture and leadership (Schein, 2004; House et al., 2004; Lagrosen and Lagrosen, 2019).

The literature emphasizes the importance of the underlying organizational culture as a critical factor for supporting and sustaining LM implementation (Hines et al., 2004; Achanga et al., 2006; Bhasin, 2012; Yadav et al., 2019). LM implementation usually entails changes in mind-sets regarding the way businesses and processes are envisioned (Bhasin and Burcher, 2006; van Assen, 2018). In this sense, a mismatched organizational culture may be the cause for ineffectiveness in LM implementation (Liker, 2004; Sim and Rogers, 2009; Liker and Rother, 2011; Chiarini and Brunetti, 2019). Previous studies have approached the association between organizational culture and isolated LM features or practices, such as Total Quality Management (Prajogo and McDermott, 2005; Baird et al., 2011; Stentoft and Freytag, 2020) and Just in Time (Gupta et al., 2000; Dahlgaard and Mi Dahlgaard-Park, 2006). However, the literature on types of organizational culture that may impair or favor LM adoption is still scarce and usually approaches organizational culture as a pre-requisite of LM (Bortolotti et al., 2015; Tortorella et al., 2019a). Studies that complement the analysis of such association (e.g. Spear and Bowen, 1999; Rother, 2009) usually encompassed Toyota as case study, neglecting the existence of other organizational culture profiles. Additionally, although Padkil and Leonard (2015) investigated the relationship between organizational culture and LM implementation, their propositions lacked empirical evidence and disregarded the effect of leadership styles, which also motivated our study.

On the other hand, specifically regarding leadership, studies such as Mann (2009), Shook (2010), Marksberry (2010), Sethuraman and Suresh (2014), van Dun et al. (2016) and Seidel et al. (2019) emphasized that leaders should extend their approaches beyond LM technicalities by adopting behaviors and styles that will nurture the development of an appropriate organizational culture. Suresh et al. (2012) suggest that to extensively implement LM companies must include

in senior management leaders who are typically transformational: they should emphasize on behaviors that eventually lead to the desired culture and outcomes to be pursued by middle managers who are mainly characterized as transactional (Emiliani, 1998). A usual assumption is that leaders implementing LM are more cooperative and excel in motivating teams (Angelis et al., 2011; Pamfilie et al., 2012; Tortorella et al., 2017; 2019a).

However, it is worth noticing that Toyota's management system may not be easily replicated by other companies (Dora et al., 2016), as their organizational culture and leadership styles may differ from Toyota (Tortorella et al., 2018; Seidel et al., 2019). That gives rise to the following research question:

RQ. *What combinations of organizational culture profile and leadership style are most likely to favor LM implementation?*

To answer that question, we surveyed 225 leaders from several manufacturers, which are undergoing different stages of LM implementation. The proposed analytical methodology clusters companies according to their organizational culture profile and level of implementation of LM practices. Then, we test for leadership styles differences across groups, and draw conclusions. This investigation identifies the combination between leadership styles and organizational culture profile that best supports the implementation of LM practices at high and low levels; both organizational culture and leadership are identified as key success factors for LM (Taleghani, 2010; Marodin and Saurin, 2013; Netland and Ferdows, 2014; Demeter and Losonci, 2019).

Our propositions build on Tortorella et al. (2016), which was also grounded on Situational Leadership theory (Blanchard and Hersey, 1969; Blanchard, 2010) to identify leadership styles and contextual variables (i.e. leadership experience, leader's age and number of followers) that best support companies undergoing LM implementation. However, the current research draws

its conclusions from a larger dataset and includes the Competing Values Framework (Quinn and Spreitzer, 1991; Cameron and Quinn, 2005) to diagnose perceived organizational culture profile that prevails in firms. The current study considered not only leadership styles, whose examination was initiated in Tortorella et al. (2016), but also the organizational culture, which was briefly discussed by Padkil and Leonard (2015) and Paro and Gerolamo (2017). Thus, the empirical examination of the effect of the relationship between leadership styles and organizational culture on LM implementation features as an original contribution of this study, providing complementary and novel insights to theory and practice.

2. Background

2.1. LM practices and Leadership

LM seeks for streamlining the flow of value through continuous waste reduction (Womack and Jones, 2003). It is also viewed as a breakage with the traditional management concepts deployed by mass-production models (Marodin *et al.*, 2015). To properly select practices and to identify their applicability in different operational contexts are an important issue for academia and organizations (Herron and Braiden, 2006; Shah and Ward, 2007; Lindsay et al., 2019). Regardless of the wide adoption of LM, a generalizable implementation approach has not been yet established (Marodin and Saurin, 2013; Tortorella et al., 2015a; Zanon et al., 2020). Thus, Table 1 lists LM practices most frequently studied in the specialized literature. Fourteen LM practices were identified; from those, ‘standardized work’ and ‘problem solving methods’ appear to be the ones with highest frequencies; while ‘cross-functional teams’ is the least cited. Despite the varying number of citations, all fourteen LM practices in Table 1 have been consistently investigated and accurately characterize environments undergoing lean implementation (Tortorella et al., 2017).

Table 1 – LM practices in the literature

LM practices	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	Level of Agreement
1- Pull system	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	82%
2- Takt-time	✓	✓		✓		✓		✓				✓		✓	✓	✓	✓	59%
3- Continuous flow	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	82%
4- Material supply	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	82%
5- Zero deffects	✓	✓			✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	71%
6- Quality assurance	✓	✓	✓	✓				✓	✓	✓				✓	✓	✓	✓	60%
7- Product/process quality planning	✓		✓	✓	✓			✓	✓	✓		✓		✓	✓	✓	✓	67%
8- Standardized work	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	88%
9- Production leveling	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	82%
10- Maintenance system	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	82%
11- Workplace organization	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	76%
12- Self-managed teams	✓					✓	✓			✓	✓		✓	✓	✓	✓	✓	59%
13- Cross-functional teams		✓		✓	✓					✓	✓			✓		✓	✓	47%
14- Problem solving methods	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	88%

Sources: (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; (16) Negrão et al. (2017); (17) Amrani and Ducq (2020).

Further, transitioning to a LM environment is a complex process that requires significant changes throughout the firm. Such transition is relevant for reinforcing the culture and behaviors required to maintain the continued efforts for improvement (Sawhney and Chason, 2005; Bortolotti et al., 2015). Leadership behaviors must be explicitly demonstrated (Hall, 2006; Angelis et al., 2011) to guarantee the success in the adoption of new practices inherent to LM transition (Fiume, 2004). Despite knowledge accumulated in previous studies, leadership is an aspect that still needs more attention from researchers (Sharma and Kirkman, 2015),

particularly with regards to favor LM implementation (Bortolotti *et al.*, 2015; Tortorella and Fogliatto, 2017; Tortorella et al. 2017; 2018).

Although the relevance of leadership for LM is already acknowledged (Womack and Jones, 2003; Liker, 2004; Negrão et al., 2020), its behavioral analysis is rarely embraced in research related to LM (Tortorella et al., 2016; Lleo et al., 2017). Few recent empirical studies are exceptions. Marksberry (2010) investigated the behaviors of operational team leaders in supporting both social and technical aspects of team members in the Toyota Production System. Team leaders' behaviors were compared against the short and long-term objectives. Results indicated that for urgent activities (i.e. short-term), team leaders displayed a task-oriented behavior, while for long-term objectives they tended to favor a relation-oriented behavior. Van Dun et al. (2016) focused on identifying prevailing values and behaviors of middle managers deemed successful in their LM implementation efforts. They analyzed managers during routine meetings with team members to conclude that four main behaviors were present, with different prevalence: (*i*) relation-oriented (54.97%), (*ii*) task-oriented (26.75%), (*iii*) change-oriented (13.01%), and (*iv*) counterproductive behaviors (5.27%). Gelei et al. (2015) examined attributes of leaders that can foster or impair LM, while Dombrowski and Mielke (2014) suggested behaviors that could contribute to a higher implementation level.

2.2. Organizational culture and LM

Organizational culture is a shared system of beliefs, values and habits that employees acknowledge within an organization (Hofstede, 2001; House et al., 2004; Schein, 2004). While LM is focused on systematically reducing waste, it also entails a significant change in existing organizational culture (Bhasin and Burcher, 2006; Erthal and Marques, 2018). A lean culture emphasizes employees' development by continuously involving them on improvement initiatives throughout the organization. In such context, success is not only a function of

performance indicators, but also a measure of employees' engagement in promoting higher performance standards (Zarbo, 2012; Demeter and Losonci, 2019). The conflicting problem is that firms are usually pressured to achieve significant results in the short-term (Bhasin, 2012). However, as pointed out by Liker (2004), Emiliani (2008), and Kull et al. (2014), LM requires a long-term commitment; to view LM as a short-term strategic approach is mistaken. Most failures related to LM implementation are attributed to the fact that time required to develop a proper organizational culture is not aligned with short-term expectations (Dahlgaard and Dahlgaard-Park, 2006; Paro and Gerolamo, 2017; Negrão et al., 2020).

Several studies focus on the role of organizational culture in determining organization success in LM implementation, as shown in Table 2. Their authors attempted to describe and formalize the characteristics of an ideal culture for extensively implementing LM, leading firms to superior performance. It is a common belief that there is a recursive interaction between organizational culture and LM; LM culture is more likely to be established as its practices are widely adopted throughout the company (Wincel and Kull, 2013; Leite et al., 2020). In this sense, continuous efforts in implementing LM practices allow employees to experience LM, and may act as a driver of cultural shift throughout the organization (Liker and Meier, 2007; Rother, 2009; Mann, 2010; Tezel et al., 2018). However, due to the existence of heterogeneous organizational culture profiles, firms undergoing lean implementation may reinforce initiatives or behaviors that lead to a sparse set of benefits (Prajogo and McDermott, 2011; DeSanctis et al., 2018). Taleghani (2010) and Padkil and Leonard (2015) argue that a mismatch between the culture profile and management practices can lead firms to distort LM effectiveness thereby, undermining potential performance improvements. Pedersen and Huniche (2010) and Kull et al. (2014) add that the lack of alignment between organizational culture and LM practices tends to decrease their adoption level, leading to inefficient adaptations, partial adoptions and poor operational results.

Authors have investigated the relationship between LM and organizational culture through different approaches. Angelis et al. (2011) used the ASSET questionnaire, developed by Cartwright and Cooper (2002), to measure the development of a commitment culture during lean implementation. Kull et al. (2014) studied the moderating role of organizational culture on the association between LM and operating performance, based upon the GLOBE National Culture Value Dimensions instrument (House et al., 2004). Similarly, Bortolotti et al. (2015) applied GLOBE to examine how organizational culture relates to the adoption of soft LM practices. Padkil and Leonard (2015) proposed the utilization of Competing Values Framework, developed by Quinn and Spreitzer (1991), to investigate organizational culture's influence on LM implementation. That framework is commonly adopted in empirical research related to organizational behaviors and performance (Gregory et al., 2009), exploring two main dimensions (effectiveness and focus) at different levels to generate four classes of organizational culture; see Figure 1. Padkil and Leonard (2015) presented propositions on the relationship between the four classes of organizational culture and LM implementation, but did not validate them empirically. Such gap has motivated our study.

Table 2 – Contributions related to LM and organizational culture available in the literature

Reference	Objectives	Findings
1	Present the critical factors that constitute a successful implementation of LM within manufacturing SMEs (small and medium enterprises).	Several critical factors that determine the success of implementing LM within SMEs are: leadership, management, finance organizational culture and skills and expertise.
2	Examine the underlying reasons surrounding low rates of successful lean implementation initiatives.	Several factors are needed for a successful LM implementation. Besides the technical aspects, the organization's culture also needs to be transformed. This transformation needs to be implemented throughout the whole organization's value chain.
3	Analyze the principles and results of LM and compare the lean philosophy with the six sigma quality process and the principles of TQM. Further, it is discussed how to build the necessary company culture for having success with both management philosophies.	There seems to be too much focus on training people in tools and techniques and, at the same time, too little emphasis on understanding the human factor, i.e. how to build the right company culture.
4	Examine the relationship between the degree of lean implementation and worker commitment; as well as the commitment effects of 21 lean work practices.	Results show seven work practices favorably influence commitment while seven others have a negative influence. The identified non-significant work practices indicate practices with a social element, such as teamwork and filling in for absent workers, have limited influence on employee commitment.
5	Explore the importance of a suitable change strategy resulting in the likelihood of a triumphant lean implementation.	While lean failures are attributable to different causes, the fundamental issues of corporate culture and change are evident. Every company needs to find its own way to implement lean, and it should be viewed as a never-ending journey.

6	Describe a functional culture of continuous improvement across a large system of medical laboratories in the Henry Ford Health System.	The empowerment of educated individuals in process improvement requires more than merely applying the principles and tools of Toyota's efficient production system in focused projects. Without a structure there will be potential chaos with so many employees anxious to use their newfound empowerment.
7	Provide an overview of existing research on culture in LM.	Review of the literature provides evidence that culture is still widely researched in lean manufacturing. A framework on the role of culture in lean manufacturing is also provided.
8	Investigate why various national culture dimensions moderate LM's effect on operating performance in manufacturing facilities worldwide.	LM is most effective in countries that value high uncertainty avoidance, low assertiveness, low future orientation, and low-performance orientation.
9	Examine whether plants that successfully implement LM are characterized by a specific organizational culture profile and extensively adopt soft LM practices.	Lean plants show higher institutional collectivism, future orientation, a humane orientation, and a lower level of assertiveness.
10	Identify the various cultural dimensions and their purported effect on LM implementation and sustainability.	Knowing which dimensions influence lean effectiveness allows managers to develop the firm's organizational culture to one that will support sustaining lean efforts. The values and norms that underlie lean processes may create conflict with the culture that already exists within the organization; such divergence retards adoption and performance.

Authors: (1) Achanga et al., 2006; (2) Bhasin and Burcher, 2006; (3) Dahlgaard and Dahlgaard-Park, 2006; (4) Angelis et al., 2011; (5) Bhasin, 2012; (6) Zarbo, 2012; (7) Ahmad, 2013; (8) Kull et al., 2014; (9) Bortolotti et al., 2015; (10) Padkil and Leonard, 2015.

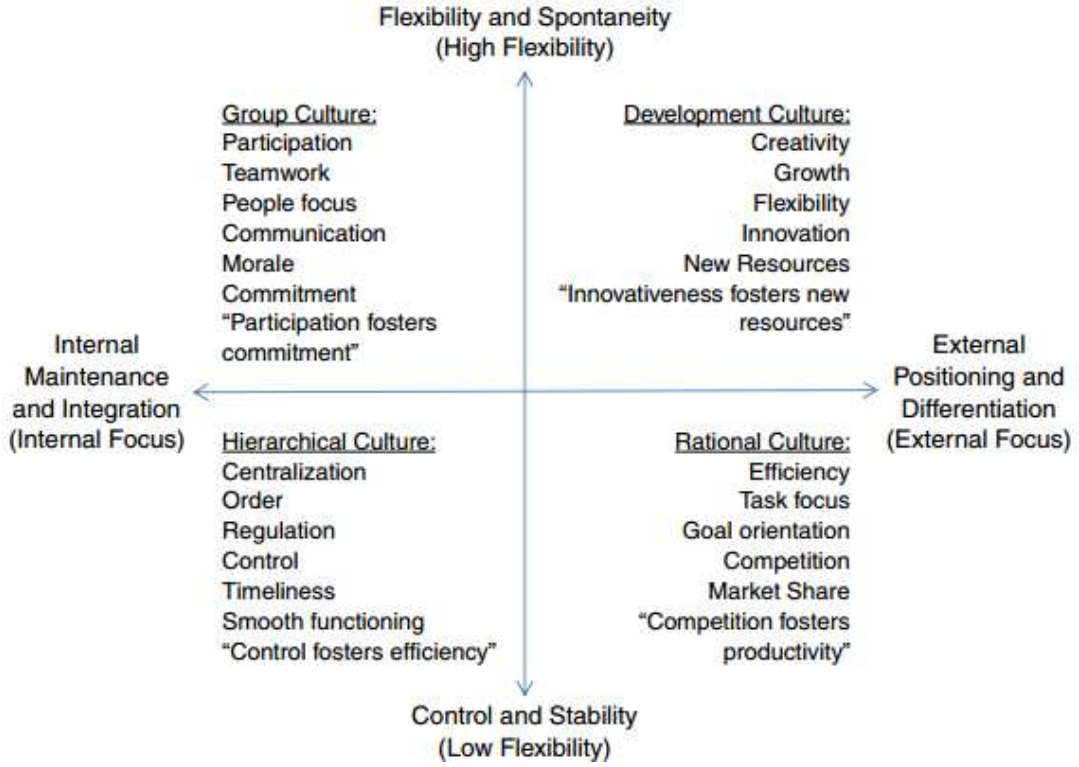

Figure 1 – Competing values framework

Source: Adapted from Cameron and Quinn (2005), p. 103.

3. Research method

This research aims at investigating the effect of the relationship between organizational culture profiles and leadership styles on LM implementation. Due to the descriptive and exploratory nature of our research, the methodological procedure followed an empirical approach. Empirical studies enable us to obtain knowledge through direct (or indirect) observation/experience (Goodwin, 2005). The quantitative analysis of empirical evidence gathered from respondents that properly met a set of pre-defined criteria provides arguments to answer the proposed research question: "what combinations of organizational culture profile and leadership style are most likely to favor LM implementation?".

Surveys are frequently used for data collection in conducting empirical operations management studies (e.g. Shah and Ward, 2007; Bortolotti et al. 2015; Tortorella et al., 2019b). Surveys provide a high level of representativeness at low cost, may be designed such that standardized stimuli are presented to respondents and provide statistical significance to results (Montgomery, 2013). In this study, we carried out an exploratory survey-based study with leaders from different organizations undergoing LM implementation. The exploratory nature of the study helped in getting more in-depth insight on understanding the effects of leadership style and organization culture on LM, thereby laying the foundation for future research. The applied method had two main steps: (i) questionnaire development and data collection, and (ii) clustering and data analysis.

3.1. Questionnaire development and data collection

Some criteria were used to select companies and respondents. This research focused on companies that were (i) implementing LM, and (ii) located in the south of Brazil, so that contextual variables' effects (e.g. workforce and regional culture) were controlled. Moreover, a minimum level of experience in LM was required, as well as respondents should be formal

leaders in their companies (e.g. General Manager, Assistant Manager, Group Leader, and Team Leader) (Liker, 2004; Tortorella et al., 2016; 2018; Tortorella and Fogliatto, 2017). The first academic reports on LM implementation in Brazilian companies date from late 1990s (e.g. Ferro, 1995; Huallacháin and Wasserman, 1999), mainly focused on the automotive supply chain. Since then, lean principles and practices have consistently and rapidly been expanded and adapted to other industries (Lucato et al., 2014). Particularly within the Brazilian manufacturing, literature evidence is prolific and applications diversified, varying from traditional sectors such as automotive (Marodin et al., 2019) and metal-mechanics (Tortorella et al., 2015b), to less usual such as oil and gas (Reis et al., 2017), and food (Costa et al., 2018). The extensive pervasiveness of LM across Brazilian manufacturers creates an adequate environment for analyzing the effects of leadership styles and organizational culture on LM implementation.

We sent questionnaires by e-mail to 759 former students of LM executive education courses. The first message including all questionnaires was forwarded in January 2018, and two follow-up e-mails subsequently sent in the next weeks. The valid final sample consisted of 225 respondents (29.64% response rate). This sample presented companies mainly from the automotive sector (41%) and categorized as large-sized (72%). Furthermore, 61% of respondents had up to 2 years of leadership experience, and 52 % were older than 30 years. The majority were male (68%) and 52% were responsible for teams larger than five employees. Group Leaders represented 33% of the respondents.

The questionnaire consisted of four parts. First, it focused on identifying the predominant organizational culture profile in the firm. To achieve that, we used the Organizational Culture Assessment Instrument, which is part of Competing Values Framework (Quinn and Spreitzer, 1991; Cameron and Quinn, 2005), to diagnose perceived organizational culture profile that prevails in the firm. In this sense, we investigated values and beliefs that define employees'

perceptions of their organizational context (Demir et al., 2011). This questionnaire explores six organizational culture dimensions: dominant characteristics, organizational leader, organizational "glue", organizational climate, criteria of success, and management style. At every dimension, scores are assigned to the occurrence of four scenarios, corresponding to four culture types, in the corresponding organization. The unit of analysis here was the company as a whole. This instrument had been previously applied by Paro and Gerolamo (2017) in a similar context, to investigate the effect of organizational culture on lean programs.

The second part targeted at assessing respondents' leadership styles. We have applied the Leadership Effectiveness & Adaptability Description questionnaire, which was proposed by Blanchard and Hersey (1969) and Blanchard (2010). Such a questionnaire has already been applied with leaders from companies undergoing LM implementation (e.g. Tortorella and Fogliatto, 2017; Tortorella et al., 2017; 2018). The questionnaire comprises 12 items related to leaders' behaviors and identifies the preferred styles, as well as leaders' flexibility to adapt to different styles. Since this part of the questionnaire provides a self-assessment of leadership preferences, the unit of analysis was the leader itself.

The third part measured the level of LM practices adoption, which was listed in the literature (see Table 1). Questions were answered using a 5-point scale where a score of 1 meant 'not used' and 5 meant 'fully adopted'. Participants were supposed to accurately indicate the adoption level of each practice in their working areas. Therefore, the unit of analysis here was the working area that respondents were responsible for, disregarding areas to which their leadership did not extend.

Finally, the fourth part of the questionnaire intended to collect data regarding contextual characteristics of respondents and their companies.

We have addressed a few procedures to mitigate potential common method bias problems in our single-respondent dataset. Among the procedural remedies to control common method bias, we designed the questionnaire providing specific wording and format to questions (Podsakoff et al., 2003). Further, questionnaires were formulated on different sources to obtain the measures of variables. For instance, to investigate organizational culture profiles, we used the instrument from Quinn and Spreitzer (1991), and to investigate leadership styles, we adapted the questionnaire from Blanchard (2010). The questionnaire was also responded anonymously.

A common method bias verification using Harman's single factor analysis was also undertaken. The logic underlying the analysis is that if common method bias is significant, the data would be sufficiently explained by a single factor based upon a Factor Analysis (Podsakoff et al., 2003; Podsakoff and Organ, 1986). To verify this issue, either an exploratory factor analysis (Malhotra et al., 2006) or a confirmatory factor analysis may be carried out (Mossholder et al., 1998). Despite exploratory factor analysis approach is widely selected for such analysis (e.g. Shah and Ward, 2007; Khanchanapong et al., 2014), we used confirmatory factor analysis as it is acknowledged as a more robust method to check the single factor hypothesis. As thresholds, we used Standardized Root Mean Squared Residual and Comparative Fit Index values larger than 0.09 and 0.95, respectively, as indicatives of single factor common bias (Hu and Bentler, 1999). Since we obtained a Comparative Fit Index of 0.841 and Standardized Root Mean Squared Residual equals to 0.065, the single factor model did not fit well to the dataset, suggesting that common method bias should not be a point of concern.

With respect to LM practices implementation, nonresponse bias was verified by testing differences in variances (Levene's test) and means (*t*-test) of responses between early and late respondents (Armstrong and Overton, 1977). No statistical differences (p-value<5%) were found for either means or variances, indicating that sample was deemed representative of the population. Although company size is claimed as influential for lean implementation (Shah and

Ward, 2003; Marodin et al., 2016), our unit of analysis was not the plant, but the working area led by the respondent. In this sense, company size's effect could be disregarded from our analysis, avoiding the risk of bias. Further, responses of the 14 LM practices were checked for reliability through Cronbach's alpha calculation; an alpha cut-off value larger than 0.6 was adopted (Meyers et al., 2006). Responses indicated high reliability, as the overall alpha value was 0.887. We did not perform an external validation of questions on LM practices, as those were already extensively applied and validated to identify the implementation level of LM (Shah and Ward, 2003; Shah and Ward, 2007; Netland et al., 2015). Further, they were deemed pertaining to a single dimension denoted as *Lean Implementation Level* (Tortorella et al., 2017; Tortorella and Fettermann, 2018).

3.2. Clustering and data analysis

In this research, two cluster analyses were performed on the same dataset using different clustering variables. In both cases, we initially adopted the hierarchical Ward's method to check the number of *k* clusters. Subsequently, *k*-means method was applied to reorganize observations into *k* clusters (Rencher, 2002).

The dataset was first clustered using respondents' leadership styles as clustering variables; the second clustering of respondents used LM practices' implementation level as variables. No formal clustering procedure was required to identify the predominant organizational culture profile perceived by respondents. Since we used the Organizational Culture Assessment Instrument, which is a 6-item ipsative measure, respondents were simply assigned to the cluster corresponding to their predominant organizational culture profile.

When clustering using the leadership styles as variables, four clusters (denoted by S_i, i=1, …, 4) were identified. Clusters' number was determined to 4, following the amount of styles, and

the *k*-means method for nominal data was used to assign observations to clusters. The primary leadership style of observations in a cluster corresponded to the one with the highest occurrence frequency. We obtained four clusters with different primary preference styles, suggesting that all leadership styles were included in the sample. Cluster sizes were as follows: S1: n_1= 45; S2: n_2= 64; S3: n_3= 46; S4: n_4= 70). The chi-square test for frequencies confirmed the existence of statistical difference in the occurrence frequency of styles in each cluster (*p*-value<0.01).

For LM implementation, the dataset was clustered into two groups based upon practices adoption level. We performed an analysis of variance to check for differences in means of practices adoption level, which indicated significant results (*p*-values<0.01) for all 14 practices. Cluster 1 consisted of 112 observations with a higher mean adoption level of LM practices and, hence, named as HLM (high level of lean manufacturing implementation). The second cluster comprised 113 observations that presented lower mean adoption levels for the same practices. Therefore, this cluster was denoted as LLM (low level of lean manufacturing implementation).

Thus, three sets of clusters were determined. The initial set is related to clusters from S1 to S4 based upon leadership styles. The second one embraces the categorization of observations in terms of organizational culture profiles (Group, Development, Hierarchical, and Rational). Finally, the last set refers to clusters HLM and LLM, which were determined on the LM practices implementation level.

We now test for differences in the frequencies across each set of groups. Initially, data was checked for normality applying Kolmogorov-Smirnof (KS) test, which indicated that a normal distribution was not followed by the data (*p*-value<0.05). Hence, suitable nonparametric techniques were used to analyze the dataset (Tabachnick and Fidell, 2013). Chi-square test with contingency tables were used to test differences in frequencies; i.e. we verified whether the frequency of leadership styles was related to LM practices at each profile of organizational

culture. Associations whose adjusted residual values were larger than or equal to |1.64| were considered significant.

4. Results and discussion

Regarding the identification of the predominant organizational culture profile among respondents, Figure 2 displays Organizational Culture Assessment Instrument results for the sample of 225 respondents. The chi-square test for frequencies confirmed the existence of statistical differences in the frequency of occurrence of organizational culture profiles (χ^2=16.97, p-value<0.01). Most respondents (n=80) categorized their firms' culture as predominantly Rational (also known as market culture). The term market aims at emphasizing transactions with external agents, such as supply chain members. The main perceived value of such organizational culture is the focus on competitive pricing and market leadership (Igo and Skitmore 2006; Demir et al., 2011). On the other hand, the Hierarchical culture (i.e. results-oriented) was the least observed in our sample (n=39). According to Cameron and Quinn (2005), that was the predominant organizational culture throughout the 1960s. Hierarchy culture emphasizes internal aspects and reinforces stability and control through determining clear tasks followed by specific standards. Hence, formal relationships are prevailing, in which leaders tend to be excellent coordinators and organizers.

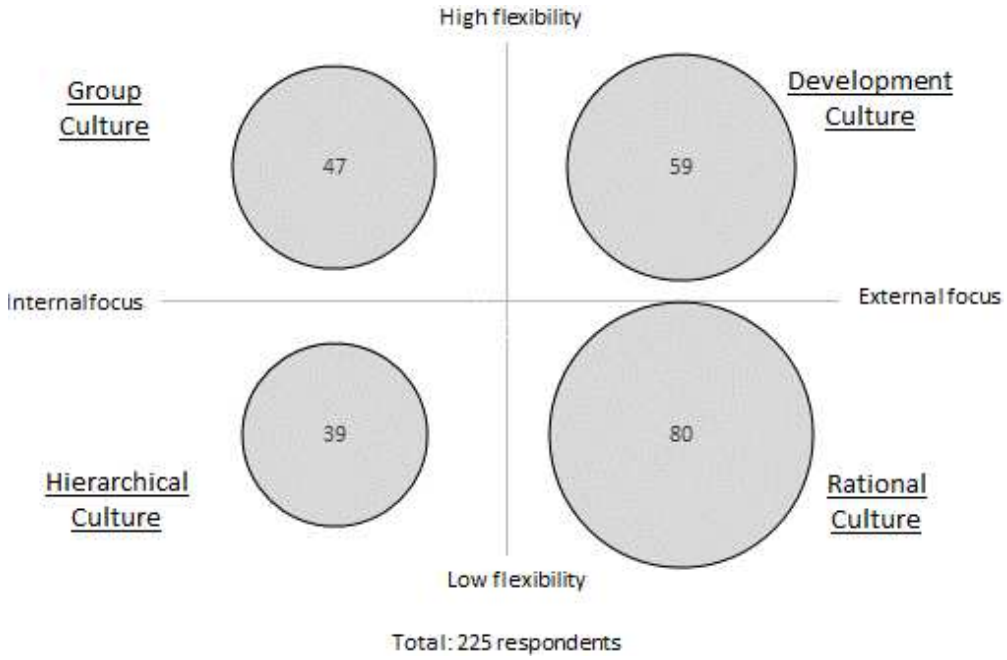

Figure 2 – Distribution of firms according to perceived organizational culture profile

Table 3 consolidates the outcomes of four contingency tables with chi-square test values. In each contingency table, an organizational culture profile is analyzed regarding leadership styles and level of LM implementation. In firms where a Group culture prevails, facilitating leadership style S3 is significantly associated with levels of LM implementation. That indicates that in organizations that share values and reinforce aspects such as participation and collaboration leaders who prefer adopting the participating/supporting behaviors are found more frequently than expected in HLM firms, and less frequently in LLM firms. Surprisingly, in organizations with the same cultural characteristic, but where LM practices are still incipient (LLM), leadership is likely to disregard both relation- and task-oriented behaviors, favoring delegating leadership style S4. These findings are consistent with previous evidence, indicating that the establishment of a Group culture occurs when goals are shared, and the achievement of higher levels of participation and morale are needed (House et al., 2004; Cameron and Quinn, 2005; Padkil and Leonard, 2015; Stentoft and Freytag, 2020). Additionally, LM implementation relies heavily on teams' efforts based on consensus building for decision making and employee

commitment (Liker, 2004; Mann, 2009; Liker and Rother, 2011; Tortorella et al., 2019a). Therefore, it becomes reasonable that a relation-oriented leadership, which characterizes style S3, tend to promote the lean change more effectively in organizations whose cultural characteristics reinforce the participation of employees, suppliers, and customers to attain a higher performance. By opposition, within such organizational culture leaders that delegate may struggle to implement LM practices and progress their team to a more advanced stage of the lean change.

Results for environments where a Development culture is predominant show that a directing leadership behavior (S1) is significantly more frequent than expected in LLM firms, and less frequent in HLM firms. Such organizational culture profile is suitable for high-risk organizations, presents little centralization, requires a higher level of employees' training, development and empowerment, and boost individuals' innovative initiatives (Ingo and Skitmore, 2006; Demir et al., 2011; Dinis-Carvalho, 2020). Contrary to commonsense belief, our sample displays a larger number of task-oriented leaders (who tell followers when and what to do) in firms with a Development culture and higher levels of LM implementation. In fact, according to studies by Spear and Bowen (1999), Spear (2004), Spear (2009), Liker and Convis (2011), and Tortorella et al. (2019b) extensive LM implementation reports usually deem rigid specifications as the core for achieving flexibility and creativity in continuous improvement initiatives. Our results illustrate such paradox.

Table 3 – Chi-square test results for organizational culture profiles regarding leadership styles and levels of LM implementation

Organizational culture profiles	Leadership style	LLM		HLM		Total frequency
		Frequency	Adjusted residual	Frequency	Adjusted residual	
Group	S1-Directing style	4	-0.01	3	0.01	7
	S2-Coaching style	8	-0.02	6	0.02	14
	S3-Facilitating style	4	-1.96**	8	1.96**	12

	S4-Delegating style	11	1.91*	3	-1.91*	14
	Total frequency	27		20		
Development	S1-Directing style	3	1.99**	8	-1.99**	11
	S2-Coaching style	10	0.45	7	-0.45	17
	S3-Facilitating style	7	-0.03	6	0.03	13
	S4-Delegating style	12	1.27	6	-1.27	18
	Total frequency	32		27		
Rational	S1-Directing style	5	-0.58	10	0.58	15
	S2-Coaching style	4	-2.11**	16	2.11**	20
	S3-Facilitating style	9	1.48	7	-1.48	16
	S4-Delegating style	14	1.14	15	-1.14	29
	Total frequency	32		48		
Hierarchical	S1-Directing style	6	-0.54	6	0.54	12
	S2-Coaching style	10	1.83*	3	-1.83*	13
	S3-Facilitating style	2	-0.79	3	0.79	5
	S4-Delegating style	4	-0.83	5	0.83	9
	Total frequency	22		17		

*significant at 10% (residual adjusted>|1.64|), **significant at 5% (residual adjusted>|1.96|) and ***significant at 1% (residual adjusted>|2.58|

In firms predominantly characterized by a Rational culture, the coaching leadership style (S2) is significantly more frequent than expected in HLM firms, and less frequent in LLM. In other words, in firms with core values centered in competitiveness and productivity/profitability, which is typical of HLM environments, leadership behaviors that are task-oriented appear to be more frequently preferred, while a relation-oriented style (S3) is less preferred. Such finding is somewhat surprising in light of the existing body of knowledge on organizational culture, which states that leaders in Rational environments are more likely to be tough and demanding (Cameron and Quinn, 2005; Demir et al., 2011). However, when these firms are implementing LM their capability of identifying and solving problems based on facts and data becomes reinforced to allow sustainable improvements (Spear, 2009; Shook, 2010; Seidel et al., 2019). Hence, in HLM firms results matter, but so do processes. Thus, in an organizational context where the search for competitiveness and productivity are key, and are achieved through a continuous problem-solving process based on scientific methods, leaders tend to direct their followers to accomplish tasks without disregarding their willingness to do it with some degree of independence.

Finally, in a Hierarchical culture the only leadership style that varies significantly with the level of LM implementation is S2 (coaching), being more frequent in firms starting LM

implementation (LLM). The combination of a Hierarchical culture that assumes intense specialization and uniformity, presenting a formal and structured workplace (Padkil and Leonard, 2015), with a leadership style that encourages creativity and experimentation through followers' development such as S2 (Thompson and Glaso, 2015), may not lead to extensive implementation of LM practices. In fact, our findings suggest that as firms presenting this kind of organizational culture advance in LM implementation, leaders shift their behaviors away from the S2 style. However, results do not point to a significantly preferable leadership style in HLM within this organizational culture.

5. Conclusion

This research was conducted assessing leaders from Brazilian manufacturers, although its outcomes might be applicable to other contexts. In this sense, implications are relevant for lean researchers and practitioners.

Regarding research implications, we present a different methodology to identify organizational culture profiles and leadership styles that can underpin to a higher level of LM implementation regarding its practices. Literature often indicates a pre-determined set of leadership behaviors while the organizational culture should support the underlying principles that drive the employees' behavioral shift from a conventional to a lean system. However, previous studies (Mann, 2010; Pamfilie et al., 2012; Dombrowski and Mielke, 2014) did not offer detailed descriptions of organizational culture characteristics and leadership styles desirable to support the transition to a lean firm, usually performing analyses that embrace high-maturity contexts, such as Toyota.

Our approach identifies preferred leadership styles, as suggested by the Situational Leadership theory (Blanchard, 2010), that support an extensive adoption of LM practices taking into

consideration organizational culture characteristics proposed by Competing Values Framework (Cameron and Quinn, 2005). Analysis of organizational culture perceived characteristics is undertaken across sets of clusters. Based upon this methodology, academicians can verify combinations of organizational culture characteristics and leadership style that are most likely to favor LM practices implementation within each cluster of respondents.

An understanding of how leadership styles and organizational culture characteristics can bear LM practices adoption is also provided, enabling more assertive management of the LM change process. For instance, in companies with organizational culture predominantly characterized as 'Development' or 'Rational', leaders who prefer the 'Coaching' style are more likely to implement LM in greater depth. However, the same style may not work properly in companies characterized by a 'Hierarchical' culture. Overall, when LM implementation is viewed as a transient process, there might be multiple ways to successfully lead teams. The interaction between organizational culture characteristics and leadership styles is associated with LM practices implementation, showing that the expected effect of such interaction may not always occur at the same extension suggested in the literature.

From a practical perspective, empirical evidence were provided on the impacts of the association between leadership styles and organizational culture profiles over LM practices implementation. For instance, with respect to firms where the Group culture prevails, we have demonstrated that leaders performing their duties in environments in which lean practices are well implemented adopt the leadership style S3. Further, the influence of a Development culture is relevant only for S1-style leaders in environments in which LM practices are extensively adopted. Evidence suggest that the examined organizational culture characteristics and leadership styles are indeed related to LM practices implementation. Thus, organizations implementing LM can understand their cultural environment and, hence, stimulate proper leadership behaviors to enhance such implementation accordingly.

It is noteworthy that this research outlines leadership styles according to organizational culture profiles in manufacturers implementing LM. The identification of such style preferences in different organizational culture contexts allows organizations to foster leadership development in a way that reinforces a more extensive adoption of LM practices within the respective organizational culture. Although changes in leadership behaviors are usually time-consuming, they are much easier to manage than changes in the organizational culture itself. Once the prevailing organizational culture profile is identified, it becomes clearer which leadership styles may be synergistic for properly achieving a more extensive LM practices adoption, giving senior managers arguments to address initiatives that may entail behavioral and cultural shifts towards a lean enterprise.

Our study has some limitations related to the characteristics of the surveyed sample. As respondents were from Southern Brazil, perceptions can be influenced by regional features. Recent research has suggested that LM is more widely adopted in developed economies, where individuals, teams and organizations have a more substantial background on the topic (Kull et al., 2014; Bortolotti et al. 2015). Furthermore, respondents' sampling was not random, which results that our findings can only be extended to similar contexts.

Additionally, authentic leaders (besides the formal job position) were not able to be identified within the study sample. Authentic leaders are likely to be aware of their thoughts and behaviors; they are deemed as aware of their own and others' values (Avolio et al., 2004). Identifying authentic leaders was out of this study's scope, hence, we understand it is a prominent research development that could be included in the future. Further, our sample was comprised of respondents from different hierarchical levels. As a result, respondents' awareness of LM implementation in their respective companies may vary. To overcome that, future studies that sample respondents with similar job titles might provide a more robust and homogeneous perspective of the actual level of lean implementation.

References

Ahmad, S. (2013). Culture and lean manufacturing: towards a holistic framework. *Australian Journal of Basic and Applied Sciences,* 7(1): 334-338.

Amrani, A., & Ducq, Y. (2020). Lean practices implementation in aerospace based on sector characteristics: methodology and case study. *Production Planning & Control*, (forthcoming).

Angelis, J., Conti, R., Cooper, C., & Gil, C. (2011). Building high-commitment lean culture", *Journal of Manufacturing Technology Management*, 22(5): 569-589.

Armstrong, J., & Overton, S. (1977). Estimating nonresponse bias in mail surveys", *Journal of Marketing Research*, 14(3): 396-402.

Avolio, B., Gardner, W., Walumbwa, F., Luthans, F., & May, D. (2004). Unlocking the mask: A look at the process by which authentic leaders impact follower attitudes and behaviors. *The Leadership Quarterly*, 15(6): 801-823.

Baird, K., Hu, K., & Reeve, R. (2011). The relationships between organizational culture, total quality management practices and operational performance. *International Journal of Operations and Production Management*, 31(7): 789–814.

Bhamu, J., & Singh Sangwan, K. (2014). Lean manufacturing: literature review and research issues. *International Journal of Operations & Production Management*, 34(7): 876-940.

Bhasin, S., & Burcher, P. (2006). Lean viewed as a philosophy. *Journal of Manufacturing Technology Management*, 17(1): 56-72.

Bhasin, S. (2012). An appropriate change strategy for lean success. *Management Decision*, 50(3): 439-458.

Bjugstad, K., Thach, E., Thompson, K. & Morris, A. (2006). A fresh look at followership: A model for matching followership and leadership styles. *Journal of Behavioral and Applied Management*, 7(3): 304.

Blanchard, K., Zigarmi, P., & Zigarmi, D. (1985). *Leadership and the one-minute manager,* Morrow, New York, NY.

Blanchard, K. (2010). *Leading at a higher level*, Prentice-Hall, Upper Saddle River, NJ.

Bortolotti, T., Boscari, S., & Danese, P. (2015). Successful lean implementation: organizational culture and soft lean practices. *International Journal of Production Economics*, 160: 182-201.

Boyle, T., Scherrer-Rathje, M., & Stuart, I. (2011). Learning to be lean: the influence of external information sources in lean improvements. *Journal of Manufacturing Technology Management,* 22(5): 587-603.

Cameron, K., & Quinn, R. (2005). *Diagnosing and changing organizational culture: based on the competing values framework*, John Wiley & Sons.

Chen, J., & Silverthorne, C. (2005). Leadership effectiveness, leadership style and employee readiness. *Leadership & Organization Development Journal*, 26(4): 280-288.

Chiarini, A., & Brunetti, F. (2019). What really matters for a successful implementation of Lean production? A multiple linear regression model based on European manufacturing companies. *Production Planning & Control*, (forthcoming).

Costa, L., Godinho Filho, M., Fredendall, L., & Paredes, F. (2018). Lean, six sigma and lean six sigma in the food industry: A systematic literature review. *Trends in Food Science & Technology*, 82: 122-133.

Dahlgaard, J., & Mi Dahlgaard-Park, S. (2006). Lean production, six sigma quality, TQM and company culture. *The TQM magazine*, 18(3): 263-281.

Demeter, K., & Losonci, D. (2019). Transferring lean knowledge within multinational networks. *Production Planning & Control*, 30(2-3): 211-224.

Demir, C., Ayyildiz Unnu, N., & Erturk, E. (2011). Diagnosing the organizational culture of a turkish pharmaceutical company based on the competing values framework. *Journal of Business Economics and Management*, 12(1): 197-217.

DeSanctis, I., Ordieres Mere, J., Bevilacqua, M., & Ciarapica, F. (2018). The moderating effects of corporate and national factors on lean projects barriers: a cross-national study. *Production Planning & Control*, 29(12): 972-991.

Dinis-Carvalho, J. (2020). The role of lean training in lean implementation. *Production Planning & Control*, (forthcoming).

Doolen, T., & Hacker, M. (2005). A review of lean assessment in organizations: an exploratory study of lean practices by electronics manufacturers. *Journal of Manufacturing Systems*, 24(1): 55-67.

Dombrowski, U., & Mielke, T. (2014). Lean leadership: 15 rules for a sustainable lean implementation. *Procedia CIRP*, 17: 565-570.

Dora, M., Kumar, M., & Gellynck, X. (2016). Determinants and barriers to lean implementation in food-processing SMEs–a multiple case analysis. *Production Planning & Control*, 27(1): 1-23.

Emiliani, M. (1998). Lean behaviors. *Management Decision*, 36(9): 615-631.

Emiliani, M. (2008). Standardized work for executive leadership. *Leadership & Organization Development Journal*, 29(1): 24-46.

Emiliani, D., & Stec, D. (2005). Leaders lost in transformation. *Leadership & Organization Development Journal*, 26(5): 370-387.

Erthal, A., & Marques, L. (2018). National culture and organisational culture in lean organisations: a systematic review. *Production Planning & Control*, 29(8): 668-687.

Ferro, J. (1995). *Current developments of the Brazilian automotive industry*. International Motor Vehicle Program, MIT. Available at: https://dspace.mit.edu/handle/1721.1/1636 (accessed on July 7th 2020).

Fiume, O. (2004). Lean at Wiremold: beyond manufacturing, putting people front and center. *Journal of Organizational Excellence*, 23(3): 23-32.

Freitas, W., Jabbour, C., Teixeira, A., & Jabbour, A. (2014). Human resource management and lean manufacturing: empirical evidence from the Brazilian automotive sector. *Production*, 24(2): 451-461.

Furlan, A., Vinelli, A., & Dal Pont, G. (2011). Complementarity and lean manufacturing bundles: an empirical analysis. *International Journal of Operations & Production Management*, 31(8): 835-850.

Gelei, A., Losonci, D., & Matyusz, Z. (2015). Lean production and leadership attributes: the case of Hungarian production managers. *Journal of Manufacturing Technology Management*, 26(4): 477-500.

Goodwin, C. (2005). *Research in Psychology: methods and design*. John Wiley & Sons, Inc., New York.

Grigg, N. P., Goodyer, J. E., & Frater, T. G. (2018). Sustaining lean in SMEs: key findings from a 10-year study involving New Zealand manufacturers. Total Quality Management & Business Excellence, 1-14.

Gupta, M., Holladay, H., & Mahoney, M. (2000). The human factor in JIT implementation: a case study of Ambrake Corporation. *Production and Inventory Management Journal*, 41(4): 29-33.

Hair, J., Tatham, R., Anderson, R., & Black, W. (2006). *Multivariate data analysis*, Pearson Prentice Hall, Upper Saddle River, NJ.

Hall, A. (2006). *Introduction to Lean* – Sustainable Quality Systems Design – Integrated Leadership Competencies from the Viewpoints of Dynamic Scientific Inquiry Learning & Toyota's Lean System Principals, Arlie Hall.

Herron, C., & Braiden, P. (2006). A methodology for developing sustainable quantifiable productivity improvement in manufacturing companies. *International Journal of Production Economics*, 104: 143-153.

Hersey, P., & Blanchard, K. (1969). Life-cycle theory of leadership. *Training & Development Journal*, 23: 26-34.

Hersey, P., Blanchard, K., & Johnson, D. (2001). *Management of organizational behavior*, 8th ed., Prentice-Hall, Englewood Cliffs, NJ.

Hines, P., Holweg, M., & Rich, N. (2004). Learning to evolve: a literature review of contemporary lean thinking. *International Journal of Operations and Production Management*, 24(10): 994-1011.

Hofstede, G. (2001). *Culture's consequences: international differences in work related values*, 2nd ed., Sage, Beverly Hills, CA.

House, R., Hanges, P., Javidan, M., Dorfman, P., & Gupta, V. (2004). *Culture, leadership and organizations* - The GLOBE Study of 62 Societies, Sage Publication, London.

Hu, L., & Bentler, P. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, 6(1): 1-55.

HUallacháin, B., & Wasserman, D. (1999). Vertical integration in a lean supply chain: Brazilian automobile component parts. *Economic Geography*, 75(1): 21-42.

Igo, T., & Skitmore, M. (2006). Diagnosing the organizational culture of an Australian engineering consultancy using the competing values framework. *Construction Innovation*, 6(2): 121–139.

Jabbour, A., Teixeira, A., Freitas, W., & Jabbour, C. (2013). Analyzing the relationship between lean manufacturing and operational performance of the automotive sector's companies in Brazil. *Revista de Administração*, 48(4): 843-856.

Jasti, N., & Kodali, R. (2015). Lean production: literature review and trends. *International Journal of Production Research*, 53(3): 867-885.

Khanchanapong, T., Prajogo, D., Sohal, A., Cooper, B., Yeung, A., & Cheng, T. (2014). The unique and complementary effects of manufacturing technologies and lean practices on manufacturing operational performance. *International Journal of Production Economics*, 153: 191-203.

Kull, T., Yan, T., Liu, Z., & Wacker, J. (2014). The moderation of lean manufacturing effectiveness by dimensions of national culture: testing practice-culture congruence hypotheses. *International Journal of Production Economics*, 153: 1-12.

Lagrosen, Y., & Lagrosen, S. (2019). Creating a culture for sustainability and quality–a lean-inspired way of working. *Total Quality Management & Business Excellence*, 1-15.

Leite, H., Bateman, N., & Radnor, Z. (2020). Beyond the ostensible: an exploration of barriers to lean implementation and sustainability in healthcare. *Production Planning & Control*, 31(1): 1-18.

Liker, J. (2004). *The Toyota Way: 14 management principles from the world's greatest manufacturer*, MacGraw-Hill, New York, NY.

Liker, J., & Convis, G. (2011). *The Toyota way to lean leadership: Achieving and sustaining excellence through leadership development*, McGraw Hill, New York, NY.

Liker, J., & Meier, D. (2007). *The Toyota Way: Application Field*, Bookman, Porto Alegre, Brazil.

Liker, J., & Rother, M. (2011). *Why Lean Programs Fail*, Lean Enterprise Institute.

Lleo, A., Viles, E., Jurburg, D., & Lomas, L. (2017). Strengthening employee participation and commitment to continuous improvement through middle manager trustworthy behaviours. *Total Quality Management & Business Excellence*, 28(9-10): 974-988.

Lindsay, C.F., Kumar, M., & Juleff, L. (2019). Operationalising lean in healthcare: the impact of professionalism. *Production Planning & Control*, (forthcoming).

Lucato, W., Calarge, F., Junior, M., & Calado, R. (2014). Performance evaluation of lean manufacturing implementation in Brazil. *International Journal of Productivity and Performance Management*, 63(5): 529-549.

Malhotra, N., Kim, S., & Patil, M. (2006). Common method variance in IS research: a comparison of alternative approaches and a reanalysis of past research. *Management Science*, 52(12): 1865-1883.

Mann, D. (2009). The missing link: lean leadership. *Frontiers of Health Services Management*, 26(1): 15-26.

Mann, D. (2010). *Creating a lean culture: tools to sustain lean conversions*, 2nd edition, Productivity Press, NY.

Marksberry, P. (2010). A new approach in analysing social-technical roles at Toyota: the team leader. *International Journal of Human Resources Development and Management*, 10(4): 395-412.

Marodin, G., & Saurin, T. (2013). Implementing lean production systems: research areas and opportunities for future studies. *International Journal of Production Research*, 51(22): 6663-6680.

Marodin, G., Frank, A., Tortorella, G., & Fetterman, D. (2019). Lean production and operational performance in the Brazilian automotive supply chain. *Total Quality Management & Business Excellence*, 30(3-4): 370-385.

Marodin, G., Frank, A., Tortorella, G., & Saurin, T. (2016). Contextual factors and Lean Production implementation in the Brazilian automotive supply chain. *Supply Chain Management: An International Journal*, 21(4): 417-432.

Marodin, G., Saurin, T., Tortorella, G., & Denicol, J. (2015). How context factors influence lean production practices in manufacturing cells. *The International Journal of Advanced Manufacturing Technology*, 1-11.

Meyers, L., Gamst, G., & Guarino, A. (2006). *Applied Multivariate Research*, Sage Publications, Thousand Oaks.

Montgomery, D. (2013). *Design and analysis of experiments*. Wiley, New York.

Mossholder, K., Bennett, N., Kemery, E., & Wesolowski, M. (1998). Relationships between bases of power and work reactions: the mediational role of procedural justice. *Journal of Management*, 24(4): 533-552.

Moyano-Fuentes, J., & Sacristán-Díaz, M. (2012). Learning on lean: a review of thinking and research. *International Journal of Operations & Production Management*, 32(5): 551-582.

Negrão, L., Godinho Filho, M., & Marodin, G. (2017). Lean practices and their effect on performance: a literature review. *Production Planning & Control*, 28(1): 33-56.

Negrão, L., Lopes de Sousa Jabbour, A., Latan, H., Godinho Filho, M., Chiappetta Jabbour, C., & Ganga, G. (2020). Lean manufacturing and business performance: testing the S-curve theory. *Production Planning & Control*, 31(10): 771-785.

Netland, T., & Ferdows, K. (2014). What to expect from a corporate lean program. *MIT Sloan Management Review*, 55(3): 83-89.

Netland, T., Schloetzer, J., & Ferdows, K. (2015). Implementing lean: The effect of takt time. *Proceedings of Euroma 2015*, Nêuchatel, Switzerland.

Ohno, T. (1988). *Toyota Production System*, Productivity Press, Portland, OR.

Padkil, F., & Leonard, K. (2015). The effect of organizational culture on implementing and sustaining lean processes. *Journal of Manufacturing Technology Management*, 26(5): 725-743.

Pamfilie, R., Petcu, A., & Draghici, M. (2012). The importance of leadership in driving a strategic lean six sigma management. *Procedia – Social and Behavioral Sciences*, 58: 187-196.

Paro, P., & Gerolamo, M. (2017). Organizational culture for lean programs. *Journal of Organizational Change Management*, 30(4): 584-598.

Pedersen, E., & Huniche, M. (2011). Determinants of lean success and failure in the Danish public sector: a negotiated order perspective. *International Journal of Public Sector Management*, 24(5): 403-420.

Podsakoff, P., MacKenzie, S., Lee, J., & Podsakoff, N. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88(5): 879–903.

Podsakoff, P., & Organ, D. (1986). Self-reports in organizational research: problems and prospects. *Journal of Management*, 12(4): 531–544.

Prajogo, D., & McDermott, C. (2005). The relationship between total quality management practices and organizational culture. *International Journal of Operations and Production Management*, 25(11): 1101–1122.

Quinn, R., & Spreitzer, G. (1991). The psychometrics of the competing values culture instrument and an analysis of the impact of organizational culture on quality of life. *Research in Organizational Change and Development*, 5: 115-142.

Reis, A., Stender, G., & Maruyama, U. (2017). Internal logistics management: Brazilian warehouse best practices based on lean methodology. *International Journal of Logistics Systems and Management*, 26(3): 329-345.

Rencher, A. (2002). *Methods of multivariate analysis*, Wiley-Interscience, New Jersey.

Rother, M. (2009). *Toyota Kata: managing people for improvement, adaptiveness and superior results*, McGraw-Hill, New York.

Saurin, T., & Ferreira, C. (2009). The impacts of lean production on working conditions: A case study of a harvester assembly line in Brazil. *International Journal of Industrial Ergonomics*, 39(2): 403-412.

Saurin, T., Ribeiro, J., & Marodin, G. (2010). Identification of research opportunities based on a survey on lean production implementation conducted in Brazilian and foreign companies. *Gestão & Produção*, 17(4): 829-841.

Sawhney, R., & Chason, S. (2005). Human behavior based exploratory model for successful implementation of lean enterprise in industry. *Performance Improvement Quarterly*, 18(2): 76-96.

Schein, E. (2004). *Organizational culture and leadership*, 3rd ed., San Francisco: Jossey-Bass.

Seidel, A., Saurin, T., Tortorella, G., & Marodin, G. (2019). How can general leadership theories help to expand the knowledge of lean leadership?. *Production Planning & Control*, 30(16): 1322-1336.

Sim, K., & Rogers, J. (2009). Implementing lean production systems: barriers to change. *Management Research News*, 32(1): 37–49.

Singh, B., Garg, S., & Sharma, S. (2010). Development of index for measuring leanness. *Measuring Business Excellence*, 14(2): 46-59.

Seidel, A., Saurin, T., Tortorella, G., & Marodin, G. (2019). How can general leadership theories help to expand the knowledge of lean leadership?. *Production Planning & Control*, (forthcoming).

Sethuraman, K., & Suresh, J. (2014). Effective leadership styles. *International Business Research*, 7(9): 165-172.

Shook, J. (2010). How to change a culture: lessons learned from NUMMI. *MIT Sloan Management Review*, 51(2): 63-68.

Shah, R., & Ward, P. (2003). Lean manufacturing: context, practice bundles, and performance. *Journal of Operations Management*, 21(2): 129-149.

Shah, R., & Ward, P. (2007). Defining and developing measures of lean production. *Journal of Operations Management*, 25(4): 785-805.

Sharma, P., & Kirkman, B. (2015). Leveraging leaders: a literature review and future lines of inquiry for empowering leadership research. *Group & Organization Management*, 40(2): 193-237.

Spear, S., & Bowen, H. (1999). Decoding the DNA of the Toyota production system. *Harvard Business Review*, 77: 96-108.

Spear, S. (2004). Learning to lead at Toyota. *Harvard Business Review*, 82(5): 78-91.

Spear, S. (2009). *Chasing the rabbit*, McGraw-Hill, New York.

Stentoft, J., & Freytag, P. (2020). Improvement culture in the public mental healthcare sector: evaluation of implementation efforts. *Production Planning & Control*, 31(7): 540-556.

Stentoft, A., & Vagn, F. (2013). Evidence of lean: a review of international peer-reviewed journal articles. *European Business Review*, 25(2): 174-205.

Stone, K. (2012). Four decades of lean: a systematic literature review. *International Journal of Lean Six Sigma*, 3(2): 112-132.

Suresh, S., Antony, J., Kumar, M., & Douglas, A. (2012). Six Sigma and leadership: some observations and agenda for future research. *The TQM Journal*, 24(3): 231-247.

Tabachnick, B., & Fidell, L. (2013). *Using multivariate statistics*, Pearson, Upper Saddle River, NJ.

Taleghani, M. (2010). Key factors for implementing the lean manufacturing system. *Journal of American Science*, 6(7): 287-291.

Tezel, A., Koskela, L., & Aziz, Z. (2018). Lean thinking in the highways construction sector: motivation, implementation and barriers. *Production Planning & Control*, 29(3): 247-269.

Thompson, G., & Glaso, L. (2015). Situational leadership theory: a test from three perspectives. *Leadership & Organization Development Journal*, 36(5): 527-544.

Tortorella, G., & Fettermann, D. (2018). Implementation of Industry 4.0 and lean production in Brazilian manufacturing companies. *International Journal of Production Research*, 56(8): 2975-2987.

Tortorella, G., Fettermann, D., Anzanello, M., & Sawhney, R. (2017). Lean manufacturing implementation, context and behaviors of multi-level leadership: a mixed-methods exploratory research. *Journal of Manufacturing Technology Management*, 28(7): 867-891.

Tortorella, G., Fettermann, D., Frank, A., & Marodin, G. (2018). Lean manufacturing implementation: leadership styles and contextual variables. *International Journal of Operations & Production Management*, 38(5): 1205-1227.

Tortorella, G., Fettermann, D., & Fries, C. (2016). Relationship between lean manufacturing implementation and leadership styles. Proceedings of the *2016 International Conference on Industrial Engineering and Operations Management*, Detroit, Michigan, USA, September 23-25, 85-96.

Tortorella, G., Fettermann, D., Marodin, G., & Fogliatto, F. (2015a). Lean Product Development (LPD) Enablers for Product Development Process Improvement. In *Research Advances in Industrial Engineering*, 31-57, Springer International Publishing.

Tortorella, G., & Fogliatto, F. (2017). Implementation of lean manufacturing and situational leadership styles: An empirical study. *Leadership & Organization Development Journal*, 38(7): 946-968.

Tortorella, G., & Fogliatto, F. (2014). Method for assessing human resources management practices and organisational learning factors in a company under lean manufacturing implementation. *International Journal of Production Research*, 52(15): 4623-4645.

Tortorella, G., Fogliatto, F., Mac Cawley Vergara, A., Luis Gonçalves Quelhas, O., & Sawhney, R. (2019a). Influence of team members' characteristics on the sustainability of continuous improvement initiatives. *Total Quality Management & Business Excellence*, (forthcoming).

Tortorella, G., van Dun, D., & de Almeida, A. (2019b). Leadership behaviors during lean healthcare implementation: a review and longitudinal study. *Journal of Manufacturing Technology Management*, 31(1): 193-215.

Tortorella, G., Viana, S., & Fettermann, D. (2015b). Learning cycles and focus groups. *The Learning Organization*, 22(4): 229-240.

Toyota. (2001). *The Toyota Way 2001*, internal document. April, Toyota Motor Corporation, Toyota City, Nagoya.

Treville, S., & Antonakis, J. (2006). Could lean production job design be intrinsically motivating? Contextual, configurational, and levels-of-analysis issues. *Journal of Operations Management*, 24: 99-123.

van Assen, M. F. (2018). Exploring the impact of higher management's leadership styles on lean management. Total Quality Management & Business Excellence, 29(11-12), 1312-1341.

van Dun, D., Hicks, J., & Wilderom, C. (2016). Values and behaviors of effective lean managers: mixed-methods exploratory research. *European Management Journal*, 1-13.

Ward, J. (1963). Hierarchical grouping to optimize an objective function. *Journal of the American Statistical Association*, 58: 263-244.

Wincel, J., & Kull, T. (2013). *People, process, and culture: lean manufacturing in the real world*, CRC Press, Boca Raton.

Womack, J., & Jones, D. (2003). *Lean Thinking: banish waste and create wealth in your corporation*, Simon & Schuster Inc., London.

Yadav, V., Jain, R., Mittal, M., Panwar, A., & Lyons, A. (2019). The propagation of lean thinking in SMEs. *Production Planning & Control*, 30(10-12): 854-865.

Zanon, L., Ulhoa, T., & Esposto, K. (2020). Performance measurement and lean maturity: congruence for improvement. *Production Planning & Control,* (forthcoming).

Zarbo, R. (2012). Creating and sustaining a lean culture of continuous process improvement. *American Journal of Clinical Pathology*, 138: 321-326.

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