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The moderating effect of management behavior for Lean and process improvement

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Abstract
It is commonly agreed that the success of Lean management is not only determined by its technical practices, but also by the so-called soft practices such as behavior and actions of employees and management. Lean Management behavior is in itself paradoxical in nature as it incorporates technical aspects (e.g., fact-based management, analysis and adhering to the standard operating procedures for sake of efficiency) and social, follower-related aspects (e.g., promotion of employee responsibility to continuously improve their work processes). In this paper, we investigate the (moderating) effect of some important Lean related management actions on the relationship between Lean and the level of process improvement: i) envisioning and communicating the meaning of Lean, ii) setting goals and active steering on improvement performance metrics and ii) encouraging continuous improvement. Survey data of 178 responses from Dutch organizations, shows that these management actions have a positive effect on both Lean and the level of process improvement. In addition, active steering on performance improvement has a reinforcing effect on the relationship between Lean and process improvement. For respondents with a low level of steering on performance improvement Lean does not lead to process improvement, while it does for respondents with average and high levels of steering on performance improvement. The more management operates on performance improvement, the more Lean will result in a higher level of process improvement.

Keywords Management behavior · Lean leadership · Lean · Process improvement · Improvement stimulation

1 Introduction

It is commonly known in literature that not only the technical practices determine the success of Lean management, also social-dynamic practices, including employee management (Bortolotti et al. 2015) and management behavior (Flynn and Saladin 2001; Mann 2009; McLachlin 1997) are important. Bortolotti et al. (2015) for instance showed that successful lean organizations use soft practices (e.g., training of employees, small group problem solving and top management leadership) more extensively than unsuccessful lean organizations. This concurs with the findings of Rahman and Bullock (2005) and Fotopoulos and Psomas (2009) that soft-practices enhance the impact of more technical quality practices on process improvement and hence on organizational performance.

Lean leadership behavior is indeed an important set of soft practices determining the success of Lean (Poksinska et al. 2013; Holmemo and Ingvaldsen 2015). Netland (2016) showed that managerial commitment and involvement is the most important soft success factor for Lean; more specifically, active leadership (i.e. clear communication about the implementation, listening to employees and explaining why Lean is needed) is considered even more important than personal participation of managers in improvement projects. Indeed, Lean leadership behavior such as promoting a vision focused on improving quality and setting ambitious goals is fundamental to effectively improve processes (Rother 2009; Spear 2004). By envisioning and articulating continuous improvement as an organizational value, leaders are able to encourage employees to improve processes, products and services (Sosik and Dionne 1997 p. 450). Management behavior of goal-setting and encouraging continuous improvement is vital for

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the improvement of operational performance through Lean because it helps to direct Lean efforts towards the expected results (Bortolotti et al. 2015; Flynn et al. 1995). Poksinska et al. (2013) therefore made a call for research to provide a deeper understanding of appropriate management behavior and actions to facilitate Lean management. With this paper, we aim to contribute to this request, by investigating how the typical management behaviors i) envisioning and communicating the meaning of Lean (Sosik and Dionne 1997; Netland 2016), ii) setting goals and active steering on improvement performance metrics (Bourne et al. 2005; Flynn and Saladin 2006) and iii) actively encouraging continuous improvement (Choi 1995; Kaynak 2003) affect Lean management. In addition, we aim to test possible moderating effects of these management behaviors on the relationship between Lean management and the level of process improvement.

This paper is organized as follows. In section 2 we briefly review the literature on Lean, Lean Leadership and corresponding management behavior. In section 3 we present the research model with hypotheses. Data, variables and research methods to validate the research model are discussed in section 4 and the statistical results are described in section 5. The findings and the implications for practice and (future) research are discussed in section 6.

2 Literature review

2.1 Lean management

Lean is a popular concept for improving operational performance in production environments (Cua et al. 2001; Shah and Ward 2003) and service environments (LaGanga 2011; Meredith et al. 2011; Swank 2003) by means of process improvements (Claycomb et al. 1999; Fullerton et al. 2003; Shah and Ward 2003; Shah and Ward 2007). Lean is therefore broadly classified under the umbrella of process improvement and world-class operations (Shah et al. 2008). Though it can be described at different levels of abstraction (e.g., it can be defined as a philosophy, as a set of principles and as bundles of practices) it is usually defined as a collection of practices that work together synergistically to create a high quality, streamlined system that produces finished products with little or no waste at the rate of customer demand (Shah and Ward 2003). Practices commonly associated with Lean include the ability to create flow and just-in-time production, including set-up time reduction and pull control (Cagliano et al. 2006; Cua et al. 2001; Sakakibara et al. 1997), quality control (Flynn et al. 1995; Narasimhan et al. 2006; Samson and Terziovski 1999) and human resource development including leadership and employee involvement (Ichniowski et al. 1997). Indeed, next to technical Lean practices (e.g., value stream mapping and improvement, benchmarking, and pull) various behavioral practices are distinguished, amongst which management commitment, employee empowerment and an open culture. Samson and Terziovski (1999) found that these types of practices impact performance differently. Mann (2009 p.15) also states that 'implementing tools represents at most 20 percent of the effort in Lean transformations; the other 80 percent of the effort is expended on changing leaders' practices and behaviors, and ultimately their mindset'. In addition, Marodin and Saurin (2015) listed 14 barriers that hamper successful Lean implementation, amongst which lack of communication throughout the organization, lack of knowledge, insecure operators to carry out improvement projects, demotivated staff, lack of management support and lack of meaning.

2.2 Lean leadership

Leadership is the intentional process to influence other people in order to guide, structure and facilitate activities and relationships in a group and/or an organization (Yukl 1989). It is the process by which an individual guides others in their pursuits, often by organizing, directing, coordinating, supporting and motivating their efforts. Lean leadership is a set of leadership competencies, practices and behaviors to successfully implement and exploit a Lean management system (Poksinska et al. 2013). Lean management is associated with leadership that facilitates and stimulates the continuous initiation and execution of improvement initiatives and coordination of change projects (Choo et al. 2007; Wu and Chen 2006). Typical Lean leadership behaviors and actions are paradoxical in nature (Choi and Eboch 1998; Lewis et al. 2014); it incorporates technical aspects like setting ambitious goals (Linderman et al. 2006), actively steering on performance improvement (Bodek 2008), managing on facts (Choi and Eboch 1998), utilizing objective data (Waldman et al. 1998), and adhering to the standard operating procedure for sake of efficiency and effectiveness on the one hand and social, follower-related aspects like improvement stimulation, promotion of employee responsibility, empowerment and collaboration to facilitate creativity and stimulate innovation on the other hand (Spear and Bowen 1999). Worley and Doolen (2006) stated that management must particularly create organizational interest in Lean by means of envisioning the Lean organization (Cua et al. 2001), and must clearly communicate both the objective of Lean and the required change to everyone in the organization (Laohavichien et al. 2011). Indeed, Lean leadership implies the creation of a True North vision, i.e. the organization's philosophical objective and long term goals (Liker and Convis 2011). By communicating objectives, shared values and principles of the Lean organization, managers influence employees' attitudes towards Lean and encourage continuous improvement (Poksinska et al. 2013). Managers accordingly control, measure and reward performance aspects that reflect values and contribute to the fulfilment of these

goals (Poksinska et al. 2013, p.893). Indeed, Lean leadership implies both steering on practices (e.g. the use of standard work) and performance (e.g. the improvement of processes and the reduction of waste) and focusing all improvement efforts towards a common goal and consequently getting immediate results (Boyer and Sovilla 2003). Typical Lean leadership behavior of higher management is having clear performance expectations, communicating a clear direction, having a vision about Lean and being personally involved (Taylor et al. 2013). Indeed, management must develop a vision and a roadmap for Lean, set targets and also follow-up on these targets (Netland 2016). We therefore conclude that i) envisioning and communicating the meaning of Lean, ii) setting goals and active steering on performance improvement metrics (Bourne et al. 2005; Flynn and Saladin 2006) and iii) encouraging continuous improvement (Choi 1995; Kaynak 2003) are important management behaviors for Lean.

3 Hypotheses and research model

There is much literature about the relationship between Lean and various types of performances, however, with mixed results. Some studies did find that Lean/JIT has a positive impact on financial performance (Claycomb et al. 1999; Fullerton et al. 2003) while others found no impact (Balakrishnan et al. 1996; Jayaram et al. 2008). Despite these differences, there is strong agreement that the salient characteristic of Lean is an emphasis on the reduction of waste (Browning and Heath 2009). This emphasis on waste reduction drove practices such as process simplification (e.g., Schonberger 2007), the identification and elimination of non-value-adding tasks and the reduction of dysfunctional variability (Hopp and Spearman 2004). Lean seeks improvement by eliminating waste brought about by supplier, customer, and internal variability (Narasimhan et al. 2006; Shah and Ward 2007). Indeed, a core activity in a Lean organization is to map, analyze and improve value streams and business processes to eliminate non-value adding activities: only those activities that really add value for the customer are kept (Jasti and Kodali 2015). Hence, waste and unnecessary (dysfunctional) variability in processing times, lead times and waiting times are eliminated as much as possible and unnecessary internal customer-supplier relationships in each process are systematically reduced (Hopp and Spearman 2004; Klassen and Menor 2007). We therefore have the following hypothesis:

- *H1: Lean is positively related to the level of process improvement*

Lean does not automatically lead to process improvement (Bessant et al. 2001; Netland et al. 2015). Demonstrable management commitment and Lean championship by management are necessary for the successful implementation of just-in-time manufacturing (McLachlin 1997) and quality improvement efforts (Waldman et al. 1998). Emphasizing customer focus and encouraging continuous improvement are core principles of effective leadership for quality (Lakshman 2006) including (a) communication and reinforcement of values and (b) articulation and implementation of vision, and (c) visionary leadership in the form of defining, communicating, and motivating continuous improvement (Anderson et al. 1994). Management sponsorship and commitment to continuous improvement and the active stimulation of staff to continuously improve their work processes are also claimed essential for Lean (Mann 2009; Spear and Bowen 1999; Worley and Doolen 2006). We therefore hypothesize that encouraging continuous improvement by management is positively related to Lean.

- *H2: Encouraging continuous improvement is positively related to Lean*

Choo et al. (2007) showed that leadership that facilitates and stimulates the continuous initiation and execution of improvement initiatives (i.e. improvement activities and projects) positively impacts learning and improvement performance. Indeed, encouraging continuous improvement by promoting employee responsibility and empowering employees to cooperate in teams to solve problems and improve their activities and processes is an important management behavior leading to higher employee involvement, improvement activities and hence higher levels of process improvement (Bessant et al. 2001). Choi (1995), Bessant et al. (2001), Wu and Chen (2006) and Anand et al. (2009) also emphasized management's proactive stance in continuous improvement. Management behavior to actively encourage continuous improvement leads to higher employee participation, involvement and commitment to continuously improve their work (Lam et al. 2015). We therefore hypothesize that encouraging continuous improvement by management is positively related to the level of process improvement.

- *H3: Encouraging continuous improvement is positively related to the level of process improvement*

An important task leaders have is to communicate desired end states of the Lean organization (Mann 2009). Indeed, the communication of an appealing vision is an important mechanism for management to motivate staff (Awamleh and Gardner 1999; Conger 1989). Management must therefore continuously put effort into promoting the reason and purpose of Lean by explaining the True North of the Lean organization and stressing the importance of building Lean practices (Rother 2009). Worley and Doolen (2006) stated that

management must particularly create organizational interest in Lean by means of visioning the Lean organization and must clearly communicate both the objective of Lean and the required change to everyone within the organization (Cua et al. 2001). The clear explanation of the meaning and the consequences of Lean positively impacts the success of Lean implementation (Laohavichien et al. 2011). Communicating the meaning of Lean and actively encouraging continuous improvement increases employees' commitment to continuous improvement initiatives (Lam et al. 2015). Indeed, the better management explains the meaning of continuous improvement, the more employees are motivated and committed to continuously improve their work processes (de Leeuw and van den Berg 2011). Encouraging continuous improvement is more effective when made clear what and why Lean is necessary for the organization. Hence, the more it is clear what Lean is and what the advantages of a Lean implementation is, the more people will contribute to it. We therefore hypothesize that communicating the meaning of Lean positively moderates the relationship between encouraging continuous improvement and Lean.

- *H4: Communicating the meaning of Lean positively moderates the relationship between encouraging continuous improvement and Lean*

According to the leadership literature, outstanding leadership is also reflected in setting and effective communicating goals (Berson and Avolio 2004). Employees display continuous improvement behavior and continually exploit corresponding improvement if they are committed to, and motivated by challenging but attainable goals (Locke and Latham 2002). Linderman et al. (2006) showed that goals can be effective in improvement teams only when teams fully adhere to the tools and method used. Goals then serve as regulators of human action by motivating improvement teams (Linderman et al. 2003). Improvement goals motivate teams to engage in intentional learning activities that create knowledge. It is precisely this phenomenon the hard technical characteristics of Lean leadership concentrates on, including having high expectations, setting ambitious goals and steering on performance improvement (Linderman et al. 2006); managing by facts by utilizing objective data (Choi and Eboch 1998), and providing timely feedback on performances (Waldman et al. 1998). Lam et al. (2015) found that rational persuasion (i.e. using logical arguments, facts and metrics to persuade staff to reach specific goals) is one of the predictors of employee commitment to continuous improvement initiatives. Moreover, active steering on improvement metrics is a mechanism to ensure that the selected improvement projects add value for the organization rather than simply targeting improvement for improvement's sake (Bateman 2005). We therefore hypothesize that active steering on performance improvement positively moderates the influence of Lean on process improvement.

- *H5: Steering on performance improvement positively moderates the relationship between Lean and process improvement*

While vision communication involves formulating relatively abstract, far-reaching, and timeless messages, effective goal setting involves formulating specific, challenging and time-constrained objectives. Powerful methods for the management of obtaining subordinates' goal-acceptance are to allow participation in the goal-setting process (Locke 1996) and the expression of positive and encouraging messages that build motivation and confidence (Podsakoff et al. 1990). The communication of strategic goals focused on improvement is positively related to building a framework for knowledge creation and learning (Choo et al. 2007) to improve performance (Flynn and Flynn 2004; Huang et al. 2011). Poksinska et al. (2013) found that the impact of a supporting structure and culture of continuous improvement on committed and motivated employees (and hence performance improvement) is much weaker than the managers' ability to keep employees committed and motivated by active steering on performance improvement. We therefore hypothesize that steering on performance improvement positively moderates the relationship between encouraging continuous improvement and process improvement.

- *H6: Steering on performance improvement positively moderates the relationship between Encouraging continuous improvement and process improvement*

To sum up, our research model is illustrated in Fig. 1.

4 Methodology

4.1 Data collection

We used data collected from business school participants in the period 2012/2013 to test the hypothesized research model. Participants were predominantly middle managers. We employed a web-based survey approach, which participants filled out before they attended an advanced Operational Excellence / Lean related course. We explicitly remarked that we would use the results anonymously during the course. 80% of the participants filled out the questionnaire resulting in 205 questionnaires, of which 198 were useful for research. About 10% of the respondents had a higher management position, 66% of the respondents were middle-managers, the remaining respondents had no management position but had job titles equivalent to internal advisors, logistics engineer and

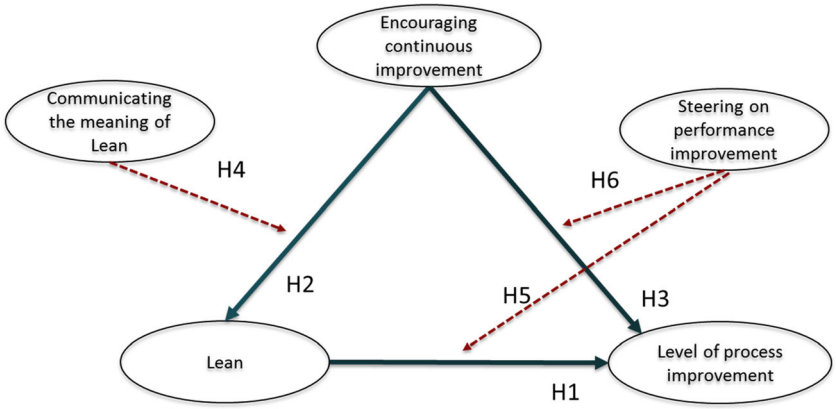

Fig. 1 The research model of this study

operations controller. The respondents averaged 8.5 years' work experience with their current organization; see Table 1. Non-response bias was evaluated by testing responses of 21 non-informants for significant differences during the courses, where they were asked to respond verbally to five substantive items related to key constructs of the whole survey. There were no significant differences ($p < .05$) in responses to any item, leading to the conclusion that non-response bias was not a problem.

4.2 Measures, scale development and purification

We adapted the familiar operationalization of Shah and Ward (2007) as a measure of Lean practices, including set-up reduction (Cronbach alpha = .85), statistical process control (Cronbach alpha = .74), pull (Cronbach alpha = .87), flow (Cronbach alpha = .68), involved employees (Cronbach alpha = .70), customer involvement (Cronbach alpha = .64), and supplier feedback (Cronbach alpha = .64). We evaluated the unidimensionality, reliability and convergent validity of the scale for Lean using confirmatory factor analysis with the software package AMOS 22. For satisfactory convergent validity, the estimated parameters between the latent variables and their indicators should be at least 0.50 (Hair et al. 1998). Some items have therefore been removed from the final scales and omitted from Table 6 of online Appendix A. The final first order measurement model fits the data sufficiently: $\chi^2 = 184.750$, df = 131, $p = .001$, CFI = 0.957, IFI = 0.958, TLI/NNFI = 0.944, RMSEA = 0.046.

With respect to the constructs related to management behavior for Lean, we operationalized communicating the meaning of Lean (Cronbach alpha = .89), encouraging continuous improvement (Cronbach alpha = .77) and steering on performance improvement (Cronbach alpha = .72) using items from

Table 1 Profile of survey respondents

NAICS codes	Type of industry	%	Function	%	Tenure	%
22	Energy	5	Non-management	23,6	<1 year	5
23	Construction	2	Middle-management	66,3	1–3 years	12
31–33	Industry	17	Higher-management	10,1	3–5 years	23
43	Wholesale Trade	6			5–10 years	15
48–49	Transportation and warehousing	3			10–15 years	1
52	Finance and Insurance	9			15–20 years	1
53	Real estate and rental and leasing	2			>20 years	8
54	Professional, scientific and technical services	12				
56	Water supply and waste management	1				
61	Educational services	5				
62	Health care and social assistance	18				
81	Other services (except public administration)	3				
92	Public services	10				
Missing		11				35
Total		100		100		100

Cua et al. (2001), Douglas and Judge (2001) and Flynn et al. (1999). The first order measurement model with these three constructs fits the data sufficiently: χ^2= 82.980, df = 41, p = .000, CFI = .955, IFI = .956, TLI/NNFI = .940, NFI = .916, RMSEA = .072; see Table 7 of online Appendix A. Finally, we developed a scale for process improvement (Cronbach alpha = .67) with items from Samson and Terziovski (1999) and Kohlbacher and Gruenwald (2011) including 'We have systematically analyzed processes and eliminated all non-value adding (dysfunctional) activities' as an example.

To test for discriminant validity, we performed chi-square difference tests on the result of CFA's for an unconstrained model versus a constrained model for each pair of constructs of the scales for Lean and management behavior, where the covariance parameter of the pair of constructs was constrained at 1 in the constrained model and set to be free in the unconstrained model. For satisfactory discriminant validity, the χ^2-difference values should be greater than 3.84 (Bagozzi 1981; Bagozzi and Phillips 1982; Kim et al. 2012; Ng et al. 2015). The χ^2-difference values ranged from 37.21 to 119.65 indicating satisfactory discriminant validity; see Table 8 of online Appendix B. In addition, the correlation matrix for all constructs with Cronbach alpha values on the diagonal, is presented in Table 2; a full correlation matrix including all sectors is presented in Table 9 in online Appendix B. Cronbach's alpha exceeds .60 for all constructs, which indicates satisfactory reliability (Cronbach 1951). In addition, all Cronbach alpha values are greater than the correlations, which also indicates satisfactory discriminant validity (see e.g., Kaynak 2003).

4.3 Control variables and common method bias

We used size, tenure in the organization, position and type of industry as control variables. Smaller organizations, for instance, typically have fewer resources for process improvement practices and Lean (Cao and Zhang 2011). Size of the organization was measured by the number of employees (logarithmized). We controlled for hierarchical level effects by including two dummy variables for position as perceived management behavior for Lean may differ across (non)management levels. Dummies are also included to control for the type of industry; because of missing values for this variable the valid number of respondents for regression analysis is 178.

Procedural methods were applied to minimize the potential for common method bias since both the independent and dependent measures were obtained from the same source (Podsakoff and Organ 1986). Our sample consisted predominantly of mid- to senior-level managers with significant levels of relevant knowledge, which tends to mitigate single source bias (Mitchell 1985). Common method bias was also reduced by separating the dependent and independent variable items over the length of the survey instrument and by assuring participants that their individual responses would be kept anonymous (Podsakoff et al. 2003). We also applied a common latent factor analysis with respect to the full measurement model in AMOS 22 to assess whether common method bias exists, but since this resulted in a small common variance and all changes in factor loadings of the items are smaller than 0.2, we conclude that the tests of reliability, validity, overall model fit and common method bias provide adequate support for the appropriateness of the model constructs.

5 Results

To estimate the research model, we used SPSS to test two moderator models with communicating the meaning of Lean (CML) and steering on performance improvement (SPI) as moderators. First, all variables were mean-centered. Note that the variance inflation factors (VIFs) for all variables are lower than the rule-of-thumb cut-off criterion of 10 (see e.g., Craney and Surles 2002) and that the correlations presented in the Table 2 are smaller than the cut-off criterion of .90, indicating that there are no collinearity problems.

In the first hierarchical regression analysis, Lean was regressed on the control variables (see model 1 in Table 3)

Table 2 Correlation matrix

	N = 198	Mean	SD	1	2	3	4	5	6	7
1	Encouraging continuous improvement	3.61	.72	.77						
2	Steering on performance improvement	3.51	.73	.51**	.72					
3	Communicating the meaning of Lean	2.35	.88	.25**	.41**	.89				
4	Lean practices	2.78	.52	.45**	.56**	.56**	.77			
5	Process improvement	2.50	.66	.48**	.55**	.48**	.62**	.67		
6	Size	3.05	.95	.05	.05	.09	.07	−.02	–	
7	Tenure	3.73	3.08	.03	.00	.00	.01	−.01	−.21**	–

** p < .01, * p < .05

Table 3 Results of regression analysis for Lean

Intercept	Model 1		Model 2		
	b .03	*t* .22	*b* .03	*t* .22	VIF
Main effects					
Communicating the meaning of Lean (CML)			.23***	6.56	1.29
Encouraging continuous improvement (ECI)			.21***	4.94	1.45
Interaction effects					
ECI × CML			.09	1.71	1.25
Control variables					
Size	.03	.69	.01	.19	1.26
Tenure	.01	.47	.00	.37	1.20
Non-management	−.13	−1.59	−.01	−.18	1.16
Higher management	.06	.53	.00	.01	1.16
Energy	.16	.99	.09	.72	1.28
Water supply and waste management	−.86	−1.92	−.59	−1.64	1.05
Construction	−.17	−.65	−.23	−1.06	1.08
Wholesale Trade	−.01	−.08	.21	1.66	1.25
Transportation and warehousing	−.13	−.62	−.16	−.93	1.18
Finance and Insurance	−.17	−1.33	−.07	−.63	1.42
Professional, scientific and technical services	−.10	−.83	−.08	−.83	1.50
Real estate and rental and leasing	−.49*	−2.07	−.27	−1.44	1.12
Other services (except public administration)	.40	1.86	.18	1.01	1.14
Public services	−.27*	−2.15	−.31**	−2.93	1.43
Educational services	−.40*	−2.52	−.25	−1.92	1.25
Health care and social assistance	−.21	−1.84	−.14	−1.46	1.83
R-squared	.17		.49		
Adjusted R-squared	.09		.43		
F improvement of fit	2.08		32.36		
p =	.012		.000		
Durbin-Watson			2.11		

Centered data, unstandardized coefficients are reported

* $p < .05$ level (2-tailed), ** $p < .01$ level (2-tailed), *** $p < .001$ level (2-tailed)

and subsequently on the variables encouraging continuous improvement (ECI), communicating the meaning of Lean (CML), and the interaction term ECI × CML; see model 2 in Table 3. Model 2 was significant given $F(19,158) = 32.36$, $p < .001$, $R^2 =$. 49, and the coefficients for CML ($b = .23$, $p < .001$) and ECI ($b = .21$, $p < .001$) were positive and significant, hence giving support for hypothesis 2. We did not find support for hypothesis 4 because the coefficient for the interaction term was not significant. Model 2 also shows that the coefficient for the dummy variable representing public services is significant ($b = -.27$, $p < .01$), which indicates that Lean is used less in public services organizations.

In the second hierarchical regression analysis, we regressed the level of performance improvement on the control variables and subsequently on the variables Lean, encouraging continuous improvement (ECI), steering on performance improvement (SPI) and the interaction terms Lean × SPI and ECI × SPI; see Table 4. Model 4 was significant given $F(21,156) = 34.34$, $p < .001$, $R^2 = .56$, as were the coefficients for Lean ($b = .58$, $p < .001$), ECI ($b = .21$, $p < .001$), SPI ($b = .21$, $p < .001$) and the interaction term Lean × SPI ($b = .35$, $p < .01$). However, the coefficient for the interaction term ECI × SPI was not significant. Table 4 also shows that different types of industries have different levels of process improvement.

We analyzed the impact of the interaction between SPI × Lean on process improvement in more detail by testing the simple slopes for respondents with low, average and high levels of SPI; see Fig. 2. Lean was significantly related to process improvement for lower levels of SPI ($b = .33$, $p = .0050$, $L\text{-}CI_{95\%} = .10$, $U\text{-}CI_{95\%} = .56$), for average levels ($b = .56$, $p = .000$, $L\text{-}CI_{95\%} = .38$, $U\text{-}CI_{95\%} = .74$) and for higher levels ($b = .78$, $p = .000$, $L\text{-}CI_{95\%} = .59$, $U\text{-}CI_{95\%} = .97$) of SPI.

Table 4 Results of regression analysis for process improvement

Intercept	Model 3		Model 4		
	b	*t*	*b*	*t*	VIF
	2.77	12.10	2.74	16.96	
Main effects					
Lean			.58***	5.93	1.72
Encouraging continuous improvement (ECI)			.21***	3.25	1.83
Steering on performance improvement (SPI)			.21***	3.38	1.80
Interaction effects					
Lean × SPI			.35**	2.73	2.04
ECI × SPI			−.03	−.42	2.21
Control variables					
Size	−.03	−.58	−.05*	−1.32	1.26
Tenure	−.01	−.30	−.01*	−.92	1.20
Non-management	−.23*	−1.90	−.07*	−.79	1.16
Higher management	−.12*	−.70	−.25*	−2.02	1.16
Energy	−.11	−.46	−.29*	−1.75	1.28
Water supply and waste management	−.42	−.64	.28	.56	1.05
Construction	.31*	.79	.31*	1.12	1.08
Wholesale Trade	.01	.03	−.02	−.13	1.25
Transportation and warehousing	.17	.53	.20*	.89	1.18
Finance and Insurance	−.18*	−.96	−.04	−.28	1.42
Professional, scientific and technical services	−.16*	−.89	−.12*	−.92	1.50
Real estate and rental and leasing	−.34*	−.97	.00	.00	1.12
Other services (except public administration)	.49*	1.56	.06	.27	1.14
Public services	−.21*	−1.10	−.06	−.46	1.43
Educational services	−.22*	−.94	.08	.50	1.25
Health care and social assistance	−.14*	−.82	−.13*	−1.07	1.83
R-squared	.07		.56		
Adjusted R-squared	−.02		.5		
F improvement of fit	.78		34.34***		
p =	.71		.000		
Durbin-Watson			2.17		

Centered data, unstandardized coefficients are reported

* $p < .05$ level (2-tailed), ** $p < .01$ level (2-tailed), *** $p < .001$ level (2-tailed)

We also evaluated the significance of this indirect effect using the Johnson-Neyman technique with bootstrapping as recommended by Preacher et al. (2007) employing 1000 bootstrap replications. The estimates of the indirect effect and (bias corrected) confidence bands are plotted in Fig. 3. Given mean-centered values of SPI, the significance region for the interaction is above the threshold value for SPI of −.97 SD from the mean, where Lean was just significantly related to process improvement ($b = .27$, $p = .05$). Of interest in this figure is the insight that the strength of the indirect effect of SPI via Lean on process improvement increases with the level of steering on performance improvement. Below the threshold, Lean has no significant effect on process improvement. Note that 11.11% of the respondents have a value of the moderator less than −.97. In all, we conclude that the test supported hypothesis 5.

Finally, we performed post-hoc analysis to evaluate whether the use of lean practices mediates the relationship between encouraging continuous improvement and process improvement as encouraging continuous improvement positively predicts Lean ($b = .21$,, $p < .001$) and both encouraging continuous improvement (direct effect of .21, $p < .001$) and Lean ($b = .58$, $p < .001$) predict process improvement. Given a total effect of encouraging continuous improvement of .43 in a simple total effect model, and a significant effect size of .21 ($\kappa^2 = .21$, $Z = 5.10$, $p < 001$) we conclude that the use of Lean partially mediates the effect of encouraging continuous improvement on process improvement.

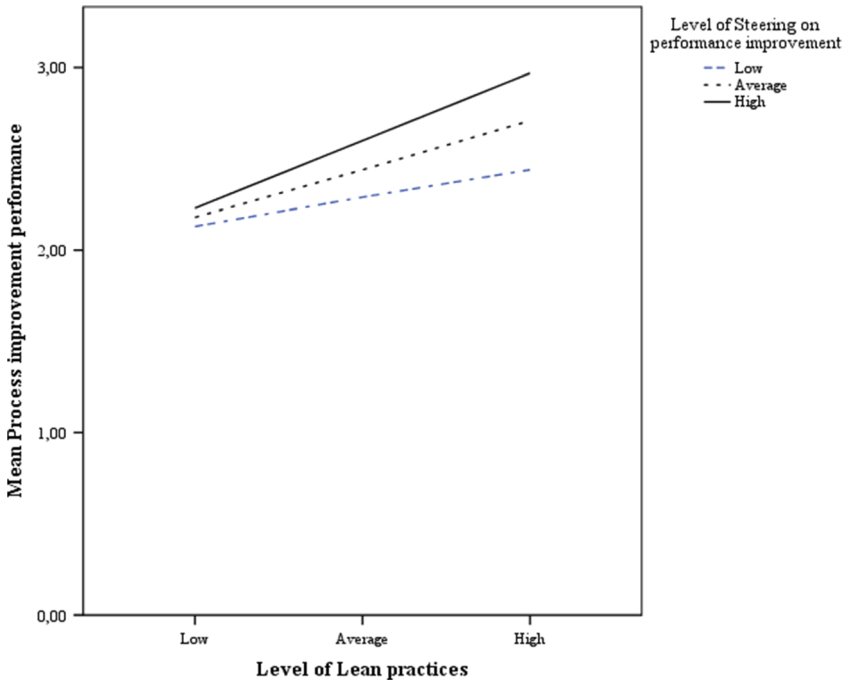

Fig. 2 Interaction of steering on performance improvement

6 Discussion

6.1 Findings

We developed and tested a research model in order to examine leadership behaviors of management to operate on performance improvement and encourage Lean management; Table 5 gives an overview of the direct and indirect testing effects. Consistent with the predictions, we found that encouraging continuous improvement is positively related to both Lean (Hypothesis 2) and the level of process improvement (Hypothesis 3), and Lean is positively related to the level of process improvement (Hypothesis 1). Though communicating the meaning of Lean is positively related to Lean, we did not find a relationship between the interaction term communicating the meaning of Lean × encouraging continuous improvement and Lean. We therefore reject Hypothesis 4.

We found something similar for active steering on performance improvement by management. Although we found a direct relationship between active steering on performance improvement and process improvement, we did not find an indirect relationship via encouraging continuous improvement.

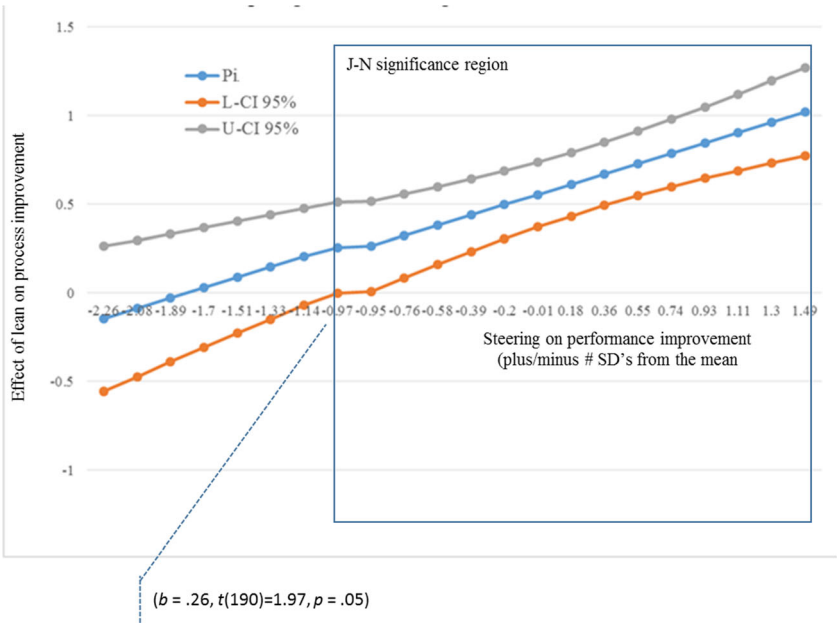

Fig. 3 J-N significant region for the moderating influence of steering on performance improvement

Table 5 Testing results

Hypothesis	Relationship	*b*	Supported?
H1	Process improvement ← Lean	.58	Yes; $p < .001$
H2	Lean ← Encouraging continuous improvement (ECI)	.21	Yes; $p < .001$
–	Lean ← Communicating the meaning of Lean (CML)	.23	$p < .001$
H3	Process improvement ← ECI	.21	Yes; $p < .001$
–	Process improvement ← SPI	.21	$p < .001$
H4	Lean ← ECI × CML	.09	No; *n.s.*
H5	Process improvement ← Lean × SPI	.35	Yes; $p < .01$
H6	Process improvement ← ECI × SPI	−.03	No; *n.s.*

Hence, we reject Hypothesis 6. However, we did find that active steering on performance improvement has a reinforcing effect on the relationship between Lean and process improvement (Hypothesis 5). For respondents with a low level of steering on performance improvement, Lean does not lead to process improvement, while it does for respondents with average and high levels of steering on performance improvement.

6.2 Implications

The practical implication of this study is that management must actively facilitate the implementation of Lean by communicating the meaning of Lean and to actively promote and stimulate the use of Lean tools and practices to continuously improve processes and activities. Communicating the meaning of Lean means that management continuously promote the reason and purpose of Lean, explain the True North of the Lean-organization (see for instance Rother 2009; Worley and Doolen 2006) and stress the importance to build and strengthen Lean capabilities. This confirms the claim of Lakshman (2006) that the degree to which leaders communicate the importance of continuous improvement of work processes and outcomes will be positively related to their effectiveness and to the unit's performance. In addition, management must encourage continuous improvement by means of promotion of employee responsibility, employee empowerment, provision of training, promotion of teamwork and team-based problem solving. Ensuring that people in various parts of the organization continuously strive to improve work processes to increase business performance is indeed an important management task in introducing and implementing Lean.

The results of this study also show that with the absence of active steering on performance improvement by management, Lean does not result in process improvement; and that the more management operates on performance improvement, the more Lean results in process improvement. This finding fits the hard technical perspective of Lean leadership that includes setting ambitious goals and steering on performance improvement (Linderman et al. 2006); managing by facts by utilizing objective data (Choi and Eboch 1998), and providing timely feedback on performances (Waldman et al. 1998). However, the results appear to be contrary to what is commonly thought of appropriate management behavior for continuous improvement and the building of a culture of continuous improvement. Excessive focus on performance improvement and performance feedback might hamper continuous improvement (Anand et al. 2009), which concurs with the claim of Browning and Heath (2009) that too much top management involvement and support of lean implementation can contribute to pushing lean implementation into the region of negative returns. Deming (1986) also contend that short-term performance goals had to be replaced with clear leadership vision concerning how the organization can achieve quality by continuous process improvement. The role of top management in culture of continuous improvement initiatives is to provide a vision that guides the formulation of goals at the middle and lower managerial levels (Anand et al. 2009). Hence, management must ensure employees' commitment through their involvement and participation in goal-setting. Communicating the organization's vision and the meaning of Lean aims to align multiple sub-goals. Subsequently, encouraging continuous improvement, the delegation of authority and the facilitation of participatory decision making leads to higher employee commitment, motivation and satisfaction, and consequently higher improvement performance. However, this does not mean that management should not actively steer on performance improvement; the question whether active steering on performance improvements and providing feedback is counterproductive on employee morale and well-being and consequently on building a culture of continuous improvement depends on, amongst others, whether employees perceive it as a job demand (something that requires sustained effort that is therefore associated with certain costs) or a job resource (something that is functional in achieving personal work goals); see for instance Bakker and Demerouti (2007). An important factor that might influence employees' performance management and feedback as a job demand or a job resource, is the attribution employees make about management's purpose in implementing performance management and feedback (Giesbers et al. 2015), that can be either commitment-focused or control-focused; see for

instance Arthur (1994). Commitment-focused attributions connote positive consequences for employees, while control-focused attributions connote negative consequences (Giesbers et al. 2015). However, more research is needed to find out how to manage this crossover point, how to balance 'control' and 'exploration' structuring behaviors (Douglas & Judge, 2001) and how to combine decentralized goal-determination with result-oriented management.

6.3 Limitations and future research

A cross-sectional research design generally limits the extent to which cause-effect relationships can be inferred. Additional research to collect and analyze longitudinal data is also recommended for this research, for instance through multiple case studies using multiple informants and multiple sources. That will also help overcome possible problems with common method bias and increase overall criterion validity as we used of single respondents' perceptual data.

Future research into Lean leadership and appropriate management behavior is recommended. This research shows that management commitment and corresponding visible management actions positively impacts the success of Lean, which corresponds with the findings of McLachlin (1997) and Mann (2009). However, as there is little empirical work that tests the type of leadership (e.g., transformational, servant, instrumental and empowering leadership) at different hierarchical levels and for different stages of Lean implementation, we would welcome future research on these Lean leadership issues.

Another interesting topic for future research is to study Lean and related management behavior (i.e. steering on performance management and feedback) on employees' well-being, as performance measures such as employee satisfaction and improvement in employee morale may have an enhancing influence on the relation between Lean and organizational performance. Also the effects of the use of technical Lean practices on job design and the consequences on employee motivation is an interesting topic for future research. Future research should also test the differences and interconnectedness of technical Lean practices and continuous improvement as an organizational infrastructure (in coherence with a culture of continuous improvement) as the results of this paper suggests that these are different, though related constructs (i.e. Lean practices predominantly refer to a more technical construct, while continuous improvement is something that occurs more organically). Indeed, this study shows that the introduction of Lean practices does not automatically lead to process improvement, but that management must actively manage that: but does that also apply for a culture of continuous improvement and infrastructural practices of continuous improvement?

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