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# Lean leadership of higher management

Research paper


In this paper, we explore the relationships between contemporary leadership styles of higher management (transformational leadership, servant leadership and empowering leadership) and Lean



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Lean is often considered as a collection of tools and practices that can be used to achieve superior operational and financial performance. However, there is consensus nowadays that the use of Lean tools and practices is a minimum, but not sufficient condition for successful Lean implementations for which a culture of continuous improvement and Lean leadership are also necessary. Though a positive connection is made in literature between Lean leadership and the transformational, servant and empowering leadership styles, empirical evidence is scarce. In this paper, we explore the relationships between these upper management leadership styles and Lean. Survey data of 199 responses from Dutch organizations shows that higher management Lean championship and improvement stimulation is indeed positively related to Lean, though improvement stimulation is particularly related to a culture of continuous improvement. Servant leadership is negatively related to the use of Lean tools and empowered leadership is positively related to the use of Lean tools. No relationships are found between the contemporary leadership styles and Lean practices.

### 1. INTRODUCTION

Lean management evolved from a mutually reinforcing set of 'best practices' to create world class operations (Schonberger, 2007). These practices include i) just-in-time (JIT) to reduce setup time, create flow and pull-based workload control (Cagliano, Caniato, & Spina, 2006; Cua, McKone, & Schroeder, 2001), ii) total quality management (TQM) to prevent quality problems and rework (Flynn, Sakakibara & Schroeder, 1995; Narasimhan, Swink & Kim, 2006) and iii) human resource development (HRM) to involve and empower employees

amongst others (Sakakibara, Flynn, Schroeder, & Morris, 1997).

Although Lean was initially considered to be a collection of tools and practices, nowadays there is widespread agreement that particularly the socio-cultural aspects of Lean, including management commitment and leadership style, determine the success of a Lean implementation (Cua et al., 2001; Mann, 2009; Sosik & Dionne, 1997; Spear & Bowen, 1990; Waldman, 1993). Nevertheless, there has been little empirical work which considers linkages between specific types of leadership and Lean (Lam, O'Donnell, & Robertson, 2015), though transformational leadership (Laohavichien, Fredendall, & Cantrell, 2011; Sosik & Dionne, 1997) and empowering leadership (Shah & Ward, 2003) are associated with Lean Leadership, since empowerment, training and coaching are important HRM-practices of Lean. Servant leadership has also been associated with Lean as it aims to empower and develop employees by providing direction and promoting employee responsibility and teamwork (Van Dierendonck, 2011; Yoshida, Sendjaya, Hirst, & Cooper, 2014), which are key aspects of Lean Leadership (Browning & Heath, 2009). Besides leadership style, management commitment and corresponding visible management actions also influence the success of Lean implementation (McLachlin, 1997), including i) management as a champion of Lean, ii) improvement stimulation by management, and iii) the creation of a continuous improvement culture. There is little empirical work that tests the impact of these management actions and behaviors on Lean implementation (Choi & Liker, 1995). With this paper, we contribute to the extant literature on Lean by examining both the impact of said management actions and the type of leadership (i.e. transformational, servant and empowering leadership) of upper management on Lean, measured by a coherent bundle of Lean practices (Shah & Ward, 2003; 2007), the use of operational Lean tools (Belekoukias, Garza-Reyes, & Kumar, 2014) and the presence of a culture of continuous improvement (Liker & Morgan, 2006).



The rest of the paper is organized as follows: section 2 presents a brief review of the relevant literature on Lean management and leadership. The research model and hypotheses are presented in section 3. Data, variables and research method to validate the research model are discussed in section 4 and the statistical results are described in section 5. Discussion of the findings and the implications for practice and (future) research are given in section 6.

## 2. LITERATURE REVIEW AND RESEARCH MODEL

### 2.1 Lean management

Lean is generally associated with the elimination of waste commonly held by firms as excess inventory or excess capacity (machine and human capacity) to buffer for variability in customer demand, value streams and processing time (de Treville & Antonakis, 2006; Hopp & Spearman, 2004). Waste reduction is typically accomplished through the reduction of dysfunctional variability and non-value added activities with the help of various operational instruments and tools to (i) specify value in terms of the customer (e.g., kano-analysis: Lin, Yang, Chan & Sheu, 2010; Ward, Liker, Cristiano, & Sobek, 1995), (ii) map the value stream – and eliminate non-value-added tasks (e.g., value stream mapping: Tyagi, Choudhary, Cai, & Yang, 2015), (iii) create continuous, single-piece flow wherever possible; (iv) only flow a product when a customer pulls it (with the help of a kanban system or a two-bin system for instance: Landry & Beaulieu, 2010), and (v) seek perfection through continuous improvement (Spear & Bowen, 1999; Womack & Jones, 1996; Womack, Jones & Roos, 1990). Mann (2009, p. 15) states, however, 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’. As a consequence, Lean requires Lean leadership and a flexible, dedicated and engaged work force, which in turn require firms to simultaneously effectively manage their social and technical systems (Shah & Ward, 2007). Lean also requires an infrastructure with

associated lean tools, instruments and practices to facilitate a culture of continuous improvement (Oliver, Delbridge, Jones, & Lowe, 1994). Having a culture of continuous improvement is related to the level of professionalism with respect to the use of tactical Lean practices (as an infrastructure) and operational Lean tools, as Lean models and tools provide an efficient and effective method for solving problems (Wu & Chen, 2006). The presence of a CI-culture implies the commitment to continuously improving the operational organization, processes and corresponding infrastructure. A culture of continuous improvement also implies the continuous development and ultimately perfection of tools and practices used (Bessant, Caffyn, & Gallagher, 2001). Having a CI-culture ensures that more use is made of different Lean tools (Wu & Chen, 2006). This view was adopted by Karlsson & Åhlström (1996) and Shah & Ward (2003) in their quest to operationalize Lean by means of Lean principles, practices and tools especially because researchers had already empirically measured just in time (McLachlin, 1997; Sakakibara, Flynn, & Schroeder, 1993) and total quality management (Dean & Bowen, 1994; Sitkin, Sutcliffe, & Schroeder, 1994) or a combination of JIT and TQM (Flynn et al., 1995) by means of practices. Shah & Ward (2007) identifies 10 Lean practices or infrastructural capabilities including involved customers, supplier feedback, developing suppliers, JIT delivery capability, flow production capability, pull control capability, setup reduction capability, controlled processes, productive maintenance and involved employees. Lean is also measured by the extent to which an organization uses operational lean tools such as value stream mapping (Tyagi et al., 2015).

### 2.2 Lean leadership

There is widespread agreement that leadership, and in particular leadership commitment and involvement, is essential to implement Lean (and related concepts JIT and TQM; e.g. Bodek, 2008; Cua et al., 2001; Peng, Schroeder, & Shah, 2008; Sosik & Dionne, 1997; Waldman, 1993). Indeed, promotion of employee responsibility, provision of training, promotion of teamwork,





and the demonstration of visible commitment are necessary leadership behaviors for facilitating continuous improvement (McLachlin, 1997). Worley & Doolen (2006) stated that management must particularly create organizational interest in Lean by means of visioning the lean organization (Cua et al., 2001), and must clearly communicate both the objective of Lean and the required change to everyone within the organization (Laohavichien, et al., 2011). Also, the management behaviors collaboration, consultation, ingratiation, inspirational appeals, and rational persuasion are significant and strong predictors of employee commitment to continuous improvement initiatives (Lam et al., 2015). Hence, employee involvement and fostering a culture of trust and respect for staff are important socio-cultural characteristics of Lean leadership (Zu, Robbins, & Fredendall, 2010). In contrast, important analytical technical characteristics of Lean leadership include: having high expectations and setting ambitious goals (Linderman, Schroeder, & Choo, 2006); management by facts and the utilization of objective data (Choi & Eboch, 1998); timely feedback and information sharing (Waldman et

al., 1998). The management actions and behavior of Lean Leadership are clearly paradoxical in nature (Choi & Eboch, 1998; Lewis, Adriopoulos, & Smith, 2014) as it incorporates technical aspects like management on facts, analysis and adhering to the standard operating procedure for sake of efficiency and effectiveness on the one hand and social, follower-related aspects like promotion of employee responsibility, empowerment and collaboration to facilitate creativity and stimulate innovation on the other hand (Spear & Bowen, 1999). It simultaneously requires the leader to meticulously act and manage consistently and to stand back and empower employees to facilitate creativity and continuous improvement. As a consequence, management actions and behaviors of Lean managers are both practice and performance focused (and to a certain extent demonstrate self-enhancement behavior) and others-focused (or even self-transcendent). Based on a brief literature review discussed in this section, we distilled 10 frequently cited management actions and behaviors associated with Lean Leadership; see Table 1.

**Table 1. Lean leadership behavior and SL/TVL/EL-factors.**

No.	Typical management action and behavior of Lean Leadership	References	Eligible factors of Servant-, Transformational- and Empowering Leadership
1	Leadership commitment, involvement & persistence, role modeling	Sosik & Dionne, 1997; Cua et al., 2001; Peng et al. 2008; Flynn and Flynn 2004; Netland et al., 2015	Empowering Leadership: Leading by Example Servant Leadership: Stewardship
2	Visioning the True North. Open & inspirational communication of future	Peng et al. 2008; Browning & Heath, 2009; Done, Voss & Rytter, 2011	Transformational Leadership: Vision Servant Leadership: Accountability by providing direction Transformational Leadership: Inspiring Communication
3	Promotion of employee responsibility & empowerment	McLachlin, 1997; Crawford et al., 1988; Flynn & Flynn, 2004; Peng et al., 2008; Netland et al., 2015	Servant Leadership: Empowerment Empowering Leadership: Participative Decision Making
4	Building and fostering a culture of trust,	Meisenheimer, 1992; Sosik & Dionne, 1997; Browning & Heath, 2009	Empowering Leadership: Showing Concern Servant Leadership: Standing Back Transformational Leadership: Supportive Leadership
5	Respect for people & humility	Mann 2009; Liker 2014; Choi & Liker 1995	Servant Leadership: Humility
6	Coaching of teams and facilitating teamwork (collaboration)	Waldman, 1993; Flynn & Flynn, 1994; McLachlin, 1997; Lakhman, 2006; Lam et al., 2015; Netland et al., 2015	Servant Leadership: Facilitating Transformational Leadership: Intellectual Stimulation Empowering Leadership: Coaching

7	High expectations, setting ambitious goals and intellectual stimulation	Linderman et al., 2006; Doeleman et al., 2012; Laohavichien et al., 2011; Waldman, 1993.	Transformational Leadership: Intellectual Stimulation
8	Timely feedback & information sharing	Choi & Eboch, 1998; Waldman et al., 1998; Done et al., 2011.	Empowering Leadership: Informing
9	Management by facts & use of objective data, visual monitoring of performance, rational persuasion	Choi & Eboch, 1998; Dahlgaard, Pettersen, & Dahlgaard-Park, 2011; Done, Voss & Rytter, 2011; Lam et al., 2015; Netland et al., 2015	Empowering Leadership: Informing
10	Celebrating and recognizing success	Waldman, 1993; Done et al., 2011; Netland et al., 2015	Transformational Leadership: Personal Recognition

### 2.3 Types of leadership

#### 2.3.1 Transformational leadership


Transformational leadership is a style of leadership in which the leader identifies the needed change, creates a vision to guide the change through inspiration, and executes the change with the commitment of the members of the group. Transformational leaders motivate followers to perform beyond expectations by transforming followers' attitudes, beliefs, and values as opposed to simply gaining compliance (Bass, 1991). Typical factors of transformational leadership are i) vision (i.e. the expression of an idealized picture of the future), 2) inspirational communication (i.e. the expression of positive and encouraging messages about the organization, and statements that build motivation and confidence, 3) intellectual stimulation (i.e. enhancing employees' interest in, and awareness of problems, and increasing their ability to think about problems in new ways), 4) supportive leadership (i.e. expressing concern for followers and taking account of their individual needs) and 5) personal recognition (i.e. the provision of rewards such as praise and acknowledgement of effort for achievement of specified goals) (Rafferty & Griffin, 2004).

A transformational leader sets ambitious organizational goals and subsequently encourages and inspires followers to perform beyond expectations to achieve these goals and uses rewards and praise to motivate followers

to go the extra mile (Yukl, 1989). A transformational leader also serves as a motivating role model (Bass, 1991) and communicates a stimulating vision of the desired end-state of the organization to enhance followers' work motivation (Shamir, House, & Arthur, 1993). Transformational leadership is therefore likely to result in growth, independence, and empowerment of followers (Avolio, Bass, & Jung, 1999). An empowered follower is self-motivated and believes in his or her ability to cope and perform successfully, leading to increased innovative performance (Jung, Chow, & Wu, 2003) and financial performance (Barling, Weber, & Kelloway, 1996).

#### 2.4.2 Servant leadership

Servant leadership is also demonstrated by empowering and developing people. It is a style of leadership in which the leader is genuinely concerned with followers (Greenleaf, 1977) aiming to develop followers their fullest potential by putting explicit emphasis on their needs (Stone, Russell, & Patterson, 2004). Indeed, the literature on servant leadership advocates that servant leaders must primarily meet the needs of others from a genuine and thorough understanding of their abilities, needs, desires, goals, and potential (Greenleaf, 1977) in order to assist and facilitate them to achieve their potential (Liden, Wayne, Zhao, & Henderson, 2008). Servant leaders do not see



employees as followers but as equals. They empower and develop people; they show humility, are authentic, accept people for who they are, provide direction, and are stewards who work for the good of the whole (Van Dierendonck, 2011). Hence, typical factors of servant leadership are (Van Dierendonck, 2011; Nuijten & Van Dierendonck, 2011): i) empowerment (i.e. fostering a proactive, self-confident attitude among followers that gives them a sense of personal power), ii) standing back (i.e. retreating into the background, giving priority to the interests of others first, and offering the necessary support and credits when a task has successfully been accomplished; Nuijten & Van Dierendonck, 2011), iii) humility (i.e. acknowledging the leader's own limitations and therefore actively seeking the contributions of others in order to overcome those limitations), iv) accountability by providing direction (i.e. holding people accountable for performance within their control), v) authenticity (i.e. expressing oneself in ways that are consistent with inner thoughts and feelings), and vi) stewardship (i.e. the willingness to take responsibility for the larger institution and to go for service instead of control and self-interest). Other operational definitions of servant leadership use similar factors (e.g., Liden et al., 2008; Sendjaya & Cooper, 2011). Servant leadership leads to higher team performance (Schaubroeck, Lam, & Peng, 2011), creativity and innovative performance (Yoshida et al., 2014) and higher firm performance (Peterson, Galvin, & Lange, 2012).

Servant leadership theory has both similarities and differences with other leadership theories. Transformational leadership and servant leadership both express concern for followers and take account of their individual needs (Stone et al., 2004). The main difference is that servant leaders are genuinely concerned with followers (Greenleaf, 1977).

Empowerment is an important factor of both transformational leadership and servant leadership behavior, but also has many similarities with the notion of empowering leadership (Pearce & Sims, 2002). A specific leadership factor may therefore be attributed to different types of leadership. Transforming influence, for instance, is a factor of both servant leadership and empowering leadership.

#### 2.4.3 Empowering leadership

Empowering as a distinctive type of leadership focuses on influencing others by developing and empowering follower self-leadership capabilities (Conger, 1989). It is essentially about encouraging participative decision making, sharing information, and the coaching and mentoring of individuals for increased innovative performance (Konczak, Stelly, & Trusty, 2000). Typical factors of empowering leadership are (see for instance Arnold, Arad, Rhoades, & Drasgow, 2000): i) leading by example (refers to a set of behaviors that show the leader's commitment to his or her own work as well as the work of his/her team members), ii) coaching (refers to a set of behaviors that educate team members and help them to become self-reliant and competent), iii) encouraging (refers to a set of behaviors that promote high performance), iv) participative decision making (refers to a leader's use of team members' information and input in making decisions), v) informing (refers to the leader's dissemination of company-wide information, such as mission and philosophy, as well as other important information), vi) showing concern (refers to a collection of behaviors that demonstrate a general regard for team members' well-being), and vii) interacting with the team (refers to behaviors that are important when interfacing with the team as a whole).

### 3. HYPOTHESES

Continuous improvement (CI) is an important part of Lean management (Huang, Rode, & Schroeder, 2011). CI is defined as the systematic effort to seek out and apply new ways of doing work i.e. actively and repeatedly making process improvements (Anand, Ward, Tatikonda, & Schilling, 2009). It can hence be viewed in terms of (a) the never-ending reciprocal relationship between process and product/service improvement and increased efficiency and effectiveness, (b) the constant enhancement of customer satisfaction by fostering a culture of trust and respect, teamwork, high expectations and open communication with employees, customers and suppliers and (c) management by fact and the use of objective data for analyzing/improving processes (Choi & Eboch, 1998; Sosik & Dionne, 1997). Lean is therefore associated with leadership that facilitates and stimulates the continuous initiation and execution of improvement initiatives and coordination of change projects (Choo, Linderman & Schroeder, 2007; Wu & Chen, 2006). We therefore have the following hypothesis:

***H1: Improvement stimulation by management is positively related to Lean***


Senior management as champions of Lean play a central role in Lean management to bridge a critical divide: the gap between the use of Lean tools and Lean thinking, i.e. principles and practices (Kanning & Bergmann, 2009). Indeed, demonstrable top leadership commitment and championship is necessary for the successful implementation of just-in-time manufacturing (McLachlin, 1997), quality improvement efforts (Waldman et al., 1998), Six Sigma (Linderman et al., 2006; Linderman, Schroeder, Zaheer, & Choo, 2003) and the promotion of improvement models and tools to build a CI-capability (Wu & Chen, 2006). A Lean champion has a genuine

interest in operational issues and has a certain level of perseverance and is not easily put off by setbacks. After all, for many, the implementation of Lean means a new way of working and a different behavior. Various barriers must be overcome to reach a situation where the entire organization continually pursues perfection (Spear & Bowen, 1999; Womack & Jones, 1996). In fact, when implementing Lean things may occasionally go wrong, something may not go according to plan or improvements may be disappointing; senior management must not give up too easily or put employees under pressure, instead it must take the organization in tow, give stability and confidence and provide possible solutions (Noone, Namasivayam, & Spitler Tomlinson, 2010). Hence, we have the following hypothesis:

***H2: Lean-championship by management is positively related to Lean***

Empowerment of employees is an important leadership behavior to stimulate the use of operational Lean tools and to perpetuate the development of Lean practices. Indeed, employee empowerment is widely touted as the defining factor of lean production (Jones, Latham, & Betta, 2013); it is an important HR practice of Lean (Shah & Ward, 2003) and involves the increase of capabilities, responsibilities, formal authority and involvement of broadly skilled employees in problem solving, participative decision making and continuous improvement (Vidal 2007). Lean requires that 'workers must have both a conceptual grasp of the production process and the analytical skills to identify the root cause of problems' so that they may 'identify and resolve problems as they appear on the line' (MacDuffie, 1997). Management in a Lean organization, therefore, inform employees about the arguments why the organization has adopted Lean, about the current performance





and future expectations and about the implications for all involved (Spear & Bowen, 1999). Lean leaders are therefore empowering leaders since they encourage employees to adhere to the principles, practices and methods of Lean. They show their commitment to Lean through active involvement and participation. Lean leaders train and coach employees in the adequate use of Lean tools, let them participate in continuous improvement projects and they encourage employees to come up with improvement suggestions (Poksinska, Swartling, & Drotz, 2013). Lean leaders listen to their followers, weigh up the arguments of all workers and take their interests into account. Indeed, consensus decision making is one of the most widely employed empowerment actions in Lean production systems (Jones et al., 2013). We therefore hypothesize that empowering leadership is positively related to both the implementation of Lean practices and the use of Lean tools.

***H3: Empowering leadership is positively related to Lean***

Empowerment requires managers to share information and knowledge that enables employees to contribute optimally to organizational performance (Ford & Fottler, 1995). Indeed, the degree to which leaders value participation and teamwork, and information sharing, will be directly related to their communication behaviors about the importance of teamwork and as such will foster an organizational culture of openness and information sharing across levels, which is essential for TQM (Lakshman, 2006) and Lean (Netland, Schloetzer, & Ferdows, 2015). With respect to skill development, Wellins, Byham, & Wilson (1991) described the manager's role as facilitating and supporting rather than directing and controlling, with a significant proportion of the leader's time spent on securing appropriate

training to ensure that employees develop the skills needed to support empowerment efforts. Lean leaders demonstrate servant leadership behavior such as promotion of employee responsibility and collaboration to facilitate creativity and stimulate innovation (Spear & Bowen, 1999). They also empower and develop employees and provide direction by means of visioning True North (Noone et al., 2010). Respect for people is another factor of servant leadership that is also a key principle of Lean (Liker, 2004). Given its emphasis on the needs and welfare of followers, servant leadership should encourage a positive social climate in which followers feel accepted and respected. By paying tribute to the workforce at the operational level, Lean leadership is similar to servant leadership (Poksinska et al., 2013). We therefore hypothesize that servant leadership is related to Lean.

***H4: Servant leadership is positively related to Lean***

Sosik & Dionne (1997) hypothesized that transformational leadership concurs with Deming's behavior factors, but did not provide empirical evidence. Laohavichien et al. (2011) empirically evaluated leadership and quality management practices and found that two factors of transformational leadership and one factor of transactional leadership influence quality management practices. Also Jung et al. (2003) found a direct and positive link between a transformational leadership style and organizational innovation and in particular with both empowerment and an innovation-supporting organizational climate. Lean leaders aim to support their teams rather than control them (Sosik & Dionne, 1997), resulting in higher worker effectiveness and employee creativity due to leader inspirational motivation (Hirst, Van Dick, & Van Knippenberg, 2009). The components of Lean leadership such as





empowering employees, participation in goal achievement, and focus on learning and personal responsibility are important aspects of transformational leadership (Poksinska et al., 2013). We therefore have the following hypothesis:

**H5: Transformational leadership is positively related to Lean**

To sum up, we have a research model as illustrated in Figure 1.

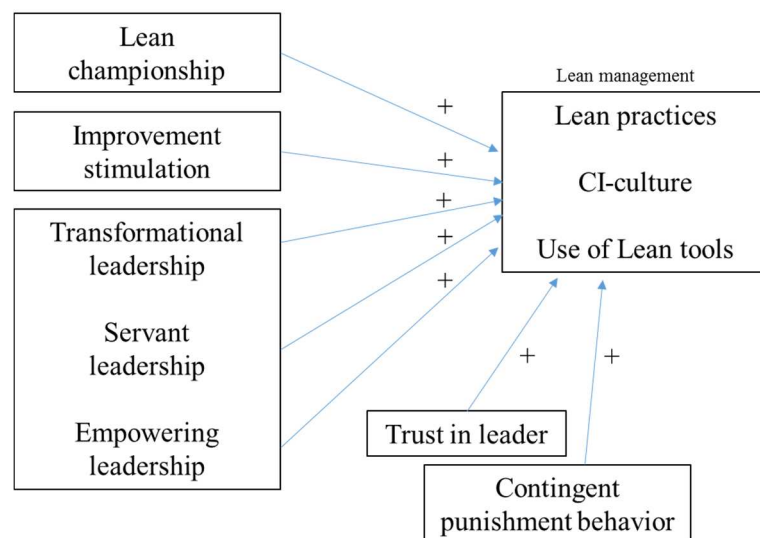


Figure 1. Research model

## 4. METHODOLOGY

### 4.1. Data collection

The data for this research was collected from participants of various courses and master classes in Operational Excellence at a Dutch business school during the period 2012/2013. Participants were predominantly middle managers and senior level managers. We employed a web-based survey approach that participants were asked to fill out before they attended the class, with the explicit remark that we would use the results anonymously during the course. 80% of the participants filled out the questionnaire resulting in 205 questionnaires, of which 199 were useful for research. The respondents averaged 8.5 years of work experience with their current organization; see Table 2. Non-response bias was evaluated by testing responses of 21 non-informants for significant differences during the courses (e.g. Mentzer & Flint, 1997), 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

Though continuous improvement (CI) is an important part of Lean (Schonberger, 2007), it is seldom included in operational definitions of Lean, but is instead often studied as a separate construct (e.g., Bessant & Francis, 1999; Peng, Schroeder, & Shah, 2008). Generally researchers operationalize Lean as either a bundle of Lean practices (e.g., Azadegan, Patel, Zangouinezhad, & Linderman, 2013; Flynn et al., 1995; Shah & Ward, 2007) or as a set of operational Lean tools (Belekoukias, Garza-Reyes, & Kumar, 2014; Karlsson & Åhlström, 1996; Rivera & Chen, 2007). To operationalize Lean we account for the use of operational Lean tools, Lean practices and a culture of continuous improvement. To increase the generalizability and applicability of our research, we adapted the familiar operationalization of Shah & Ward

(2007) as a measure of infrastructural Lean practices for both manufacturing and services industries. The final scale includes visual management (VM), pull control (PC), good housekeeping (GH), setup-reduction (SR) and group technology (GT). The constructs supplier feedback, JIT-delivery and supplier development were omitted from the scale due to low values of Cronbach's alpha. Items were estimated through respondents' perceptual evaluation on a five-point Likert scale. The response categories for each item were anchored by 1 (strongly

disagree) and 5 (strongly agree): see appendix A1. We evaluated the uni-dimensionality, reliability and convergent validity of each scale in this research using confirmatory factor analysis in the software package AMOS 22. The final second order measurement model of Lean practices fits the data well (Browne & Cudeck, 1992):  $\chi^2 = 95.715$ ,  $df = 60$ ,  $p = .002$ , CFI = .962, IFI = .963, TLI/NNFI = .994, NFI = .908, RMSEA = .055: see Table A.1 in appendix A.

Table 2. Profile of survey respondents

NAICS codes	Type of industry	%	Function	Percentage	Years of employment at this organization	%
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		7				35
Total		100		100		100

We operationalized 'Use of Lean tools' using scales for visual management tools (VMT), pull control tools (PCT), Kaizen improvement tools (KIT) and root-cause analysis tools (RCT). The final second order measurement model of Use of Lean Tools fits the data well:  $\chi^2 = 32.682$ ,  $df = 31$ ,  $p = .384$ , CFI = .997, IFI = .997, TLI/NNFI = .994, NFI = .943 and RMSEA = .017; see Table A.2 in appendix A. CI-Culture (Cronbach alpha = .75) is operationalized using items from Huang et al. (2011). Subsequently we constructed an aggregate Lean scale based on the variables

Lean practices, Use of Lean tools and CI-Culture that has a Cronbach's alpha value of .87. The constructs Lean championship (Cronbach alpha = .67) and Improvement stimulation by management (Cronbach alpha = .78) are operationalized using items from Cua et al. (2001), Douglas & Judge (2001) and Flynn, Schroeder & Flynn (1999). The measurement model with these two constructs fits the data sufficiently:  $\chi^2 = 24.064$ ,  $df = 13$ ,  $p = .031$ , CFI = .964, IFI = .966, TLI/NNFI = .922, NFI = .928 and RMSEA = .070; see Table A.4 in appendix A.

With respect to the type of Leadership, we measured the perceived leadership style of upper management. Transformational leadership was measured using the five-factor model of Rafferty & Griffin, (2004) and includes the factors vision, inspirational communication, intellectual stimulation, supportive leadership and personal recognition. The final first order measurement model of Transformational leadership sufficiently fits the data:  $\chi^2 = 132.262$ ,  $df = 67$ ,  $p = .000$ , CFI = .948, IFI = .950, TLI/NNFI = .919, NFI = .903 and RMSEA = .070; see Table A.5 in the appendix. Servant leadership was operationalized using the operationalization of Van Dierendonck & Nuijten (2011). The final first order measurement model including the factors empowerment, humility and standing back fits the data well:  $\chi^2 = 115.138$ ,  $df = 62$ ,  $p = .000$ , CFI = .956, IFI = .957, TLI/NNFI = .936, NFI = .912 and RMSEA = .066; see Table A.6 in appendix A. Empowering leadership was measured using the Empowering Leadership Questionnaire (ELQ) of Arnold et al. (2000) with the factors coaching, informing, leading by example, showing concern/interacting with the team, and participative decision making. The final measurement model of Empowering Leadership fits the data well:  $\chi^2 = 125.418$ ,  $df = 45$ ,  $p = .000$ , CFI = .950, IFI = .952, TLI/NNFI = .923, NFI = .912, RMSEA = .075; see Table A.7. Finally, we measured the constructs contingent punishment behavior (Podsakoff, Tofoor, Grover, & Huber, 1984) and trust in/loyalty to the Leader (Podsakoff, MacKenzie, Moorman, & Fetter, 1990) to test for possible alternative explanations for the variance in the dependent variables: see Tables A.8 and A.9 in the appendix. Descriptive statistics, Cronbach's alpha and correlation matrix for all constructs are presented in Table 3. Cronbach's alpha exceeds .65 for all constructs which indicates satisfactory reliability (Cronbach, 1951).

#### 4.3. Control variables and common method bias

In this research we used respondent's hierarchical position, education and tenure within the organization and organization size as control variables. Size for instance was measured by the number of employees

(logarithmized); smaller organizations typically have fewer resources for the implementation of process improvement initiatives or supply chain management practices (Cao & Zhang, 2011). However, we found no significant relationship ( $p < .05$ ) between the control variables and the constructs in the statistical models used. 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 & Organ, 1986). We ensured our sample included 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, MacKenzie, Lee, & Podsakoff, 2003). A statistical approach for assessing whether common method bias exists is Harman's one-factor test (Podsakoff et al., 2003). All variables were entered into an unrotated exploratory factor analysis to test whether the majority of the variance can be explained by a single factor, but this was not the case. We therefore conclude that the tests of reliability, validity, overall model fit and common method bias provide adequate support of the appropriateness of the constructs.

#### 5. RESULTS:

To test the proposed hypotheses, we performed multiple hierarchical regression analyses. First we regressed the control variables, the leadership styles and management behavior for continuous improvement on the aggregate Lean construct. The variance inflation factors (VIFs) for all variables are lower than the rule-of-thumb cut-off criterion of 10 (Craney & Surles, 2002) and also the correlations presented in Table 3 are smaller than the cut-off criterion of .90 for collinearity problems. Model 3 in Table 4 shows the main effects referring to Hypotheses 1-5. This model shows that empowered leadership is positively related ( $b = 0.61$ ,  $p < .1$ ) and servant leadership is negatively related ( $b = -0.55$ ,  $p < .1$ ) to Lean. Transformational



leadership has no significant impact on the aggregate variable Lean. Lean Championship ( $b = 0.31, p < .01$ ) and Improvement Stimulation ( $b$

$= 0.33, p < .05$ ) by management are positively related to Lean.

**Table 4: Results of hierarchical regression analysis for aggregate Lean construct**

Variable	Model 1		Model 2		Model 3	
	<i>b</i>	<i>t</i>	<i>b</i>	<i>t</i>	<i>b</i>	<i>t</i>
Size	0.06	0.55	0.03	0.31	-0.03	-0.35
Hierarchical position	-0.15	-0.76	-0.07	-0.35	-0.24	-1.52
Tenure	0	-0.07	0	0.05	-0.01	-0.69
Education	-0.1	-0.53	0	-0.02	-0.15	-1.06
Contingent Punishment Behavior			0.08	0.34	0.07	0.43
Trust in/Loyalty to the Leader			0.12	0.74	-0.07	-0.58
Transformational Leadership (TL)			-0.45	-1.1	-0.08	-0.25
Empowered Leadership (EL)			1.07*	2.34	0.61†	1.75
Servant Leadership (SL)			-0.42	-0.95	-0.55†	-1.7
Lean Championship (LC)					0.31**	3.19
Improvement Stimulation (IS)					0.33*	2.53
$R^2$	.03		.24		.62	
$F$ improvement of fit	.19		2.36		15.85****	
$\Delta R^2$	.03		.21		.38	

\*\*\*  $p < .001$  level (2-tailed) †  $p < .1$  level (2-tailed)

\*\*  $p < .01$  level (2-tailed)

\*  $p < .05$  level (2-tailed)

Since Lean Championship and Improvement stimulation by management are stronger predictors for Lean than the type of leadership, we also conducted hierarchical regression analyses for the single Lean constructs separately (i.e. CI-Culture, Lean practices and Use of Lean tools); see model 3 in Table 5 for

the results. The type of leadership (i.e. servant leadership, empowered leadership and transformational leadership) is not related to CI-Culture; only the extent of improvement stimulation by management is significantly related to CI-Culture ( $b = 0.82, p < .001$ ).

**Table 5: Results of hierarchical regression analysis for CI-culture, Lean practices and Use of Lean tools**

Dependent: CI-culture →	Model 1: CI-Culture		Model 2: CI-Culture		Model 3: CI-Culture	
Variable	b	t	b	t	b	t
Size	.11	1.14	.08	.87	.04	.68
Hierarchical position	.22	1.44	.17	1.14	.06	.60
Tenure	-.02	-.34	.00	-.03	-.023	-1.25
Education	-.24	-1.85	-.19	-1.58	-.11	-1.34
Contingent Punishment Behavior			.13	1.04	.01	.16
Trust in/Loyalty to the Leader			.23	1.07	.09	.63
Transformational Leadership			.17	.50	.09	.36
Empowered Leadership			-.11	-.34	-.22	-1.02
Servant Leadership			.14	.46	.18	.85
Lean Championship					.00	.01
Improvement Stimulation					.82***	8.89
R <sup>2</sup>	.06		.23		.63	
F	1.52		3.53**		45.10***	
ΔR <sup>2</sup>	.06		.13		.40	
Dependent: Lean practices →	Model a: Lean practices		Model b: Lean practices		Model c: Lean practices	
Variable	b	t	b	t	b	t
Size	-.03	-.31	-.03	-.31	-.08	-1.02
Hierarchical position	-.05	-.32	-.07	-.50	-.16	-1.31
Tenure	-.03	-1.10	-.02	-.70	-.02	-1.05
Education	-.05	-.40	-.02	-.18	-.01	-.14
Contingent Punishment Behavior			.24	1.81†	.13	1.11
Trust in/Loyalty to the Leader			.01	.07	-.04	-.22
Transformational Leadership			-.10	-.29	-.06	-.20
Empowered Leadership			.44	1.26	.17	.59
Servant Leadership			-.34	-1.08	-.24	-.94
Lean Championship					.22**	2.60
Improvement Stimulation					.22	1.43
R <sup>2</sup>	.03		.14		.47	
F	.49		1.29		10.55***	
ΔR <sup>2</sup>	.03		.11		.33	
Dependent: Use of Lean tools →	Model I: Use of Lean tools		Model II: Use of Lean tools		Model III: Use of Lean tools	
Variable	b	t	b	t	b	t
Size	.10	.96	.05	.48	.04	.47
Hierarchical position	-.16	-.77	-.12	-.58	-.33†	-1.88
Tenure	.03	.87	.03	1.20	.03	1.04
Education	-.05	-.25	.05	.27	-.030	-.57
Contingent Punishment Behavior			.10	.70	.09	.22
Trust in/Loyalty to the Leader			.12	.48	.12	.62
Transformational Leadership			-.17	-.42	-.04	-.12
Empowered Leadership			.92*	2.08	.92*	2.50
Servant Leadership			-.65	-1.48	-.99*	-2.69
Lean Championship					.42***	4.49
Improvement Stimulation					.08	.63
R <sup>2</sup>	.03		.15		.44	
F	.37		1.48		12.66***	
ΔR <sup>2</sup>	.03		.12		.29	

\*\*\*  $p < .001$  level (2-tailed) †  $p < .1$  level (2-tailed)\*\*  $p < .01$  level (2-tailed)\*  $p < .05$  level (2-tailed)



The leadership styles are not related to the level of Lean practices (see model c in Table 5). However, Lean Championship by management is positively related to Lean practices ( $b = 0.22, p < .05$ ). In contrast, empowered leadership ( $b = 0.92, p < .05$ ) is positively related and servant leadership ( $b = -0.99, p < .05$ ) is negatively related to the use of Lean tools. Lean championship by management positively impacts the use of Lean tools ( $b = 0.42, p < .001$ ).

The results from the regression analyses for use of Lean tools give reason to explore the influence of individual leadership characteristics on the use of Lean tools. We therefore regressed the control variables, all individual leadership factors and the variables Lean Championship and Improvement stimulation by management on the use of Lean tools; see Table 6.

**Table 6: Results of hierarchical regression analysis of Lean tools**

Dependent: Use of Lean tools →	Model 1		Model 2		Model 3	
Variable	<i>b</i>	<i>t</i>	<i>b</i>	<i>t</i>	<i>b</i>	<i>t</i>
Size	.10	.96	-.07	-.62	-.04	-.37
Hierarchical position	-.16	-.77	-.16	-.74	-.27	-1.46
Tenure	.02	.87	.01	.37	.01	.62
Education	-.05	-.25	.06	.32	.08	.46
Contingent Punishment Behavior			.16	.94	.14	.98
Trust in/Loyalty to the Leader			.04	.13	-.03	-.13
SL: Empowerment			.15	.56	-.15	-.62
SL: Standing Back			-.45*	-2.33	-.47**	-2.88
SL: Humility			-.29	-.99	-.46†	-1.89
TL: Vision			-.43**	-2.40	-.18	-1.15
TL: Inspiring Communication			.13	.520	.02	.11
TL: Intellectual Stimulation			-.39	-1.42	-.45†	-2.00
TL: Supportive Leadership			-.04	-.19	.11	.60
TL: Personal Recognition			.18	.92	.24	1.45
EL: Leading by Example			.14	.69	.04	.24
EL: Participative Decision Making			.13	.51	.18	.83
EL: Informing			.73**	3.11	.67**	3.14
EL: Showing Concern			.30	1.26	.41*	2.04
Lean championship					.38***	3.91
CI-Culture					.33†	1.94
Improvement Stimulation					-.21	-1.10
<i>R</i> <sup>2</sup>	.03		.40		.62	
<i>F</i>	.37		1.80†		7.65***	
$\Delta R^2$	.03		.37		.22	

\*\*\*  $p < .001$  level (2-tailed) †  $p < .1$  level (2-tailed)

\*\*  $p < .01$  level (2-tailed)

\*  $p < .05$  level (2-tailed)

The factors Standing Back ( $b = -0.47, p < .01$ ) and Humility ( $b = -0.46, p < .1$ ) of the servant leadership scale, and Intellectual Stimulation ( $b = -0.45, p < .1$ ) of the transformational leadership scale are negatively related to the use of Lean tools. Informing ( $b = 0.67, p < .001$ ) and Showing Concern ( $b = 0.41, p < .01$ ) of the empowered leadership scale are positively

related to use of Lean tools. In addition, we find Lean championship by management ( $b = 0.38, p < .001$ ) and having a CI-culture ( $b = 0.33, p < .1$ ) to be positively related to the use of Lean tools.

## 6. DISCUSSION

### 6.1. Conclusions

Top management sponsorship, demonstrable commitment, active involvement and improvement stimulation are frequently cited as important leadership behaviors for Lean management (e.g., Mann, 2009; Worley & Doolen, 2006). Indeed, in literature a positive connection is made between Lean leadership and contemporary leadership styles such as transformational leadership (Dean & Bowen, 1994; McLachlin, 1997; Sosik & Dionne, 1997) and servant leadership (e.g., Poksinska et al., 2013) but empirical evidence is often lacking. Based on a sample of 199 respondents, this study shows that Lean Championship and improvement stimulation by higher management is indeed positively related to Lean, though improvement stimulation is

particularly related to the presence of a CI-culture. Servant leadership as a leadership style of higher management is negatively related to the use of Lean tools but not related to the level of Lean practices or to the presence of a CI-culture, while empowered leadership is positively related to the use of Lean tools. No relations are found between the contemporary leadership styles and Lean practices. This concurs with the findings of Laohavichien et al. (2011) that the interactions of transformational leadership style with infrastructure and core practices are not significant. Considering the individual leadership factors we found that three individual factors (i.e. Standing Back, Humility and Intellectual Stimulation) are negatively related to the use of Lean tools, and two individual factors (i.e. Informing and Showing Concern) are positively related to the use of Lean tools; see Table 7.

**Table 7: Direct effects testing results.**

Hypothesis	Path	<i>b</i>	<i>t</i>	Supported?	Model	Alternative
H1	Lean ← Improvement stimulation	0.31	4.3	Yes; $p < .05$	Table 4	In particular related to CI-culture
H2	Lean ← Lean Championship	0.51	2.21	Yes; $p < .001$	Table 4	
H3	Lean ← Empowering leadership	0.89	1.96	Yes; $p < .1$	Table 5	In particular related to use the of Lean tools
H4	Lean ← Servant leadership	-.99*	-2.69	No; $p < .05$	Table 5	
H5	Lean ← Transformational leadership	-0.65	-1.69	No; $p > .1$	Table 4	Not related to Lean

### 6.1. Implications

This research shows that senior management must not hold back from Lean initiatives but actively promote and stimulate the use of Lean tools to continuously improve processes and activities. Top management must continue their efforts promoting the reason and purpose of Lean, explaining the True North of the Lean-organization and stressing the importance to build and strengthen Lean capabilities and practices as a type of Lean infrastructure. Senior management must also inform staff about the expectations and consequences of implementing Lean and take the time to address any concerns about or resistance to Lean and the inevitable change; it is important that senior management shows concern for similar issues.

This result does not imply that servant leadership and transformational leadership are unrelated to Lean Leadership as Lean requires different Lean leadership behavior on different hierarchical levels (Mann, 2009). This concurs with Lakshman (2006) that involvement and participation of managers and employees at all levels are important to the successful management of quality in organizations. Lean leadership at the supervisory level and thus leader behaviors of supervisors or lower level managers are probably more people-oriented and others-focused to stimulate participation and teamwork, promote employee responsibility by showing trust in people then senior management; future research The paradoxical nature of Lean leadership (i.e. technical aspects versus the social, follower

related aspects) will apparently be balanced among various hierarchical levels by means of spatial separation (e.g., Poole & Van de Ven, 1989).

#### 6.2. Limitations and future research

Like any research, this study also has its limitations. First, we studied Lean leadership behavior of senior management with the help of data comprising various types of respondents of various organizations. Although the scales in this study are sufficiently reliable, future research could set up an experiment in which the difference is being studied in leadership behavior between two or more groups of Lean adopters (given various Lean implementation stages) versus a group of non-adopters. This also offers the opportunity to investigate differences in leadership at different hierarchical levels. Second, we do not have all possible factors of servant leadership and empowering leadership included in the study. Sendjaya & Cooper (2011), for example, have proposed slightly different factors as a scale for servant leadership than we used in this study. Since there is no ultimate consensus on the appropriate factors to measure each type of leadership, future research could involve alternative factors of servant, transformational and empowering leadership.

One of the primary cultural features associated with leadership is power distance (Swierczek, 1991). Strong, decisive leaders are expected in high power distance cultures, with less decisive leaders perceived as weak and ineffectual (Blunt, 1988). Future research could include such cultural factors as possible mediating factors. In addition, although this study associates the theories of transformational, servant and empowering leadership with Lean leadership, this paper did not address the underlying influence processes (Yukl, 1989) impacting Lean leadership nor is the relationship of the leader's behavior to various stages of Lean implementation examined. Future research could resolve this issue.

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Table 3. Descriptive statistics and correlation matrix with Cronbach's alpha on the diagonal.

		Mean	S.D.	1	2	3	SL	5	6	7	8	9	TL	11	12	13	14	EL	16	17	18
1	SL: Empowerment	3.97	.56	.81																	
2	SL: Standing Back	3.16	.82	.570**	.69																
3	SL: Humility	3.43	.79	.668**	.691**	.92															
SL	Servant Leadership	3.52	.66	.827**	.846**	.875**	.84														
5	TL: Vision	3.74	.78	.446**	.365**	.515**	.530**	.85													
6	TL: Inspiring Communication	3.76	.78	.641**	.592**	.740**	.766**	.468**	.68												
7	TL: Intellectual Stimulation	3.69	.70	.684**	.602**	.712**	.781**	.532**	.825**	.82											
8	TL: Supportive Leadership	3.55	.74	.699**	.639**	.781**	.811**	.357**	.644**	.597**	.77										
9	TL: Personal Recognition	3.66	.73	.588**	.509**	.718**	.718**	.325**	.637**	.597**	.633**	.78									
TL	Transformational Leadership	3.67	.60	.757**	.689**	.856**	.892**	.688**	.890**	.881**	.811**	.785**	.87								
11	EL: Leading by Example	3.69	.70	.526**	.537**	.668**	.676**	.535**	.575**	.552**	.571**	.503**	.700**	.90							
12	EL: Participative Decision	3.73	.63	.690**	.605**	.799**	.799**	.372**	.641**	.598**	.727**	.634**	.738**	.544**	.80						
13	EL: Informing	3.69	.73	.568**	.532**	.694**	.756**	.666**	.611**	.667**	.531**	.542**	.767**	.579**	.532**	.87					
14	EL: Showing Concern	3.54	.72	.512**	.472**	.709**	.680**	.328**	.555**	.539**	.619**	.512**	.645**	.513**	.679**	.462**	.71				
EL	Empowering Leadership	3.66	.57	.711**	.659**	.848**	.863**	.584**	.738**	.738**	.750**	.677**	.874**	.816**	.840**	.806**	.821**	.84			
16	Contingent Punishment Behavior	3.66	.69	.344**	.204**	.413**	.397**	.305**	.343**	.474**	.143	.357**	.407**	.239**	.294**	.442**	.174*	.362**	.87		
17	Trust in/Loyalty to the Leader	4.01	.61	.675**	.491**	.735**	.752**	.512**	.613**	.602**	.706**	.548**	.740**	.548**	.642**	.592**	.585**	.726**	.276**	.806	
18	Lean Championship	2.99	.95	.206**	.098	.146	.196*	.042	.219**	.232**	.105	.223**	.223**	.056	.116	.187*	.110	.149	.029	.146	.667
19	Improvement Stimulation	3.58	.68	.344**	.159*	.275**	.276**	.301**	.306**	.339**	.191*	.246**	.341**	.219**	.282**	.398**	.195**	.326**	.220**	.287**	.366**
20	CI-Culture	3.37	.77	.258**	.149	.287**	.257**	.191*	.317**	.319**	.202**	.234**	.329**	.165*	.299**	.320**	.249**	.320**	.267**	.316**	.271**
21	Visual Management Tools	1.79	1.10	-.012	-.209*	-.095	-.086	-.012	-.019	.008	-.167*	.057	-.024	-.118	-.073	.120	-.016	-.040	.097	-.093	.344**
22	Pull Control Tools	1.24	.64	.083	-.085	.019	.040	-.021	.005	.076	.040	.107	.048	-.046	.069	.134	.074	.065	.053	-.050	.314**
23	Improvement Tools	2.03	1.06	.054	-.110	-.078	-.039	-.010	-.020	.005	-.013	.003	.006	-.067	-.085	.113	-.108	-.056	-.056	-.036	.422**
24	Kaizen Improvement Tools	1.57	.92	-.059	-.176*	-.058	-.112	-.105	.000	-.029	-.007	.047	-.018	-.032	-.057	.092	-.023	-.016	-.001	-.025	.370**
25	Lean Tools	1.66	.68	.081	-.063	.094	.112	.021	.064	.059	.058	.149	.090	-.024	.086	.265**	.088	.111	.054	-.013	.514**
26	Setup Reduction	2.59	.79	.037	-.100	.069	.039	.122	.039	.145	-.020	.088	.101	.059	.009	.217*	.047	.106	.102	.001	.274**
27	Visual Management	2.75	.95	-.003	-.162*	-.002	-.031	.007	.042	.043	-.097	-.019	.010	-.063	-.108	.161*	-.036	-.015	.083	-.050	.350**
28	Pull Control Practice	2.52	.94	.055	-.132	-.068	-.089	.030	.077	.087	-.038	.067	.110	-.004	-.038	.022	.045	.009	.096	-.013	.396**
29	Good Housekeeping	2.15	1.03	.023	-.246**	-.098	-.146	.002	-.025	-.014	-.005	.047	.027	-.044	-.033	.037	-.032	-.042	.013	.006	.477**
30	Group Technology	3.37	.80	.052	-.063	.001	.008	.211**	.001	.042	-.060	-.063	.046	.122	.031	.118	.028	.093	.009	.051	.279**
31	Lean Practices	2.67	.70	.054	-.238*	-.016	-.045	.110	.001	.070	-.074	.075	.100	.032	-.036	.159	-.032	.035	.091	.006	.493**
32	LEAN	2.22	.70	.176	-.051	.193	.199	.133	.128	.158	.084	.228	.187	.101	.187	.336**	.205	.253*	.201	.106	.575**
33	Size	2.99	.88	.089	-.055	.107	.052	-.047	.123	.102	.089	.125	.093	.133	.144	.027	.169*	.152*	.019	.113	.106
34	Hierarchical position	.86	.57	.043	.029	-.004	.019	.077	.101	.082	-.001	.050	.069	.015	.030	.073	-.029	.021	.052	.051	.125
35	Tenure	3.73	3.08	.058	.052	-.055	.008	-.035	-.022	-.052	.011	-.011	-.035	-.084	-.013	-.017	.038	-.025	-.131	-.012	.040
36	Education	5.65	.63	-.078	-.113	-.124	-.136	.016	-.146*	-.109	-.123	-.026	-.074	.041	-.136	-.060	-.121	-.081	-.029	-.124	-.062

		Mean	S.D.	19	20	21	22	23	24	Lean Tools	26	27	28	29	30	Lean Practices	LEAN	33	34	35
19	Improvement Stimulation	3.58	.68	.78																
20	CI-Culture	3.37	.77	.687**	.75															
21	Visual Management Tools	1.79	1.10	.261**	.184*	.71														
22	Pull Control Tools	1.24	.64	.126	.248**	.422**	.71													
23	Kaizen Improvement Tools	2.03	1.06	.340**	.240**	.335**	.370**	.81												
24	Kaizen Improvement Tools	1.57	.92	.071	.048	.552**	.480**	.320**	.68											
25	Lean Tools	1.66	.68	.266**	.283**	.764**	.741**	.659**	.772**	.69										
26	Setup Reduction	2.59	.79	.415**	.371**	.423**	.372**	.238*	.312**	.432**	.85									
27	Visual Management	2.75	.95	.401**	.354**	.646**	.404**	.363**	.457**	.597**	.527**	.74								
28	Pull Control Practice	2.52	.94	.247**	.203*	.449**	.505**	.254**	.485**	.499**	.543**	.576**	.85							
29	Good Housekeeping	2.15	1.03	.216**	.209**	.488**	.659**	.396**	.686**	.733**	.392**	.468**	.596**	.89						
30	Group Technology	3.37	.80	.240**	.147	.319**	.194*	.133	.316**	.341**	.322**	.419**	.320**	.281**	.70					
31	Lean Practices	2.67	.70	.410**	.373**	.678**	.657**	.399**	.694**	.779**	.720**	.831**	.840**	.799**	.628**	.82				
32	LEAN	2.22	.70	.585**	.719**	.687**	.716**	.537**	.653**	.866**	.610**	.755**	.661**	.761**	.492**	.876**	.87			
33	Size	2.99	.88	.081	.125	-.012	-.008	.136	.011	.100	-.137	.107	.020	-.027	.048	.030	.098	-		
34	Hierarchical position	.86	.57	.264**	.161*	.102	-.051	-.005	.042	.031	.165	.121	-.035	.071	.160*	.108	.057	.021	-	
35	Tenure	3.73	3.08	.055	.012	.070	.106	-.008	-.054	.072	-.045	.012	-.032	-.001	-.068	-.062	-.003	-.195**	.142*	-
36	Education	5.65	.63	-.060	-.072	-.039	.020	-.010	.047	.051	-.037	-.033	.031	.056	.098	.095	.068	.260**	.049	.001

\*\* p < .01 level (2-tailed).

\* p < .05 level (2-tailed).



## APPENDIX A: SURVEY ITEMS &amp; RELIABILITY AND ITEM STATISTICS

## A.1. Lean practices

**Set-up-reduction (SR)***Range: strongly disagree – strongly agree (5-point Likert scale)*

In this business unit (location, department)...

- SR1 employees are trained to reduce set-up time
- SR2 we have a structured method to reduce set-up time
- SR3 we continuously *try* to reduce set-up time

**Visual management (VM)***Range: strongly disagree – strongly agree (5-point Likert scale)*

In this business unit (location, department)...

- VM1 signs, symbols and lines are used to indicate how process run, where material deliveries take place, what the walking paths are and where stock locations are.
- VM2 a visual control system is present at the workplace that provides information about the production, quality and / or backlog.
- VM3 information screens (that can be seen by everyone) are present that show performances (daily or weekly performance).
- VM4 *up-to-date work instructions are present in any workplace and visualized by using characters (symbols), photos, and procedures.* - not included in the final scale to increase AVE

**Pull control (PC)***Range: strongly disagree – strongly agree (5-point Likert scale)*

In this business unit (location, department)...

- PC1 *we have a method to keep the work in progress in the primary processes low and evenly (so that work flow and peaks are avoided).* - not included in the final scale to increase AVE
- PC2 we work with pull-control, in which production is initiated from a real customer order.
- PC3 we use a pull-control system
- PC4 work at a particular machine / workstation is triggered by a pull-signal from a subsequent machine / workstation.

**Good housekeeping (GH)***Range: strongly disagree – strongly agree (5-point Likert scale)*

In this business unit (location, department)...

- GH1 all employees know what the 5S method.
- GH2 *for every workstation / workplace it is made clear what resources and tools are needed and what is actually 'unnecessary' to have present at the workplace.* - not included in the final scale
- GH3 everyone in the organization knows why 5S has been introduced and applied
- GH4 *all 'unnecessary' items removed (such as unused tools, rejected materials or scrap, personal materials, outdated information).* - not included in the final scale to increase AVE

**Group technology (GT)***Range: strongly disagree – strongly agree (5-point Likert scale)*

In this business unit (location, department)...

- GT1 *resources and/or workstations are grouped in such a way that each product family can be produced in a continuous flow* - not included in the final scale to increase AVE
- GT2 products and/or services are grouped by routing and/or similar process steps.
- GT3 products and/or services are grouped according similar activities and actions to produce the products and/or services

Table A.1. Reliability and item statistics for second order measurement model of Lean practices (Chi-square = 95,715,  $df$  = 60,  $p$  = .002, CFI = 0.962, IFI = 0.963, TLI/NNFI = 0.994, NFI = 0.908, RMSEA = 0.055).

	Cronbach alpha for scale	Alpha if item deleted	Item-to-total correlation	Mean	SD	Item loadings	Average Variance Extracted
Set-up Reduction	0.846						0.610
SRC1		0.750	.752	2.59	.902	0.775	
SRC2		0.835	.665	2.49	.964	0.747	
SRC3		0.773	.727	2.69	.911	0.82	
Visual	0.735						0.521
VMC1		0.667	.445	2.57	1.177	0.589	
VMC2		0.571	.597	2.73	1.100	0.776	
VMC3		0.556	.611	2.73	1.176	0.784	
Pull Control	0.848						0.663
PCC2		0.724	.650	2.56	1.192	0.775	
PCC3		0.675	.755	2.51	1.009	0.875	
PCC4		0.712	.674	2.36	1.052	0.789	
Good	0.891						0.802
GHC1			.635	1.86	1.014	0.886	
GHC3			.626	2.05	.989	0.905	
Group Tech	0.700						0.538
GTC2			.528	3.37	.953	0.754	
GTC3			.527	3.38	.930	0.712	
LeanInfra							0.511
Chi-square =	CFI	0.962		Set-up Reduction		0.739	
$df$ = 60	IFI	0.963		Visual Management (VMC)		0.831	
$p$ = .002	TLI/NNFI	0.994		Pull Control (PCC)		0.763	
	NFI	0.908		Good Housekeeping (GHC)		0.654	
	RMSEA	0.055		Group Technology (GTC)		0.557	

**A.2. Use of Lean tools**

Range: 5-point Likert scale and the answering option 'Do not know'

1 – No, not at all, 2 – Yes, but only rarely, 3 – Yes, occasionally, 4 – Yes, on a regular basis, 5 – Yes, extensively

In this business unit (location, department) we make use of...

**Visual management tools**

VMT1 glass walls and/or white boards with performance indicators

VMT2 value stream maps on the shop floor and/or within the office

VMT3 visual quality control charts - not included in the final scale to increase AVE

**Pull control tools**

PCT1 kanban cards (system)

PCT2 two-bin cards (system)

PCT3 takt times

**Kaizen improvement tools**

KIT1 PDCA improvement cycle

KIT2 Large kaizen events (kaizen improvement sessions that take longer than 1 day)

KIT3 Small kaizen bubbles (improvement sessions that take no longer than 1 day)

**Root-cause analysis tools**

RCT1 Fish-bone diagram (cause-and-effect diagrams)

RCT2 5Why's method

**Table A.2. Reliability and item statistics for second order measurement model of Use of Lean Tools (chi-square = 32.682, df. = 31,  $p = .384$ , CFI = 0.997, IFI = 0.997, TLI/NNFI = 0.994, NFI = 0.943, RMSEA = 0.017).**

	Cronbach alpha for scale	Alpha if item deleted	Item-to-total correlation	Mean	SD	Item loadings
Visual management tools	0.708					
VMT1			.504	2.06	1.517	0.754
VMT2			.504	1.8	1.222	0.673
Pull control tools	0.709					
PCT1		0.548	.582	1.27	.837	0.780
PCT2		0.635	.514	1.22	.832	0.753
PCT3		0.666	.487	1.27	.797	0.721
Kaizen improvement tools	0.808					
KIT1		0.888	.527	2.95	1.506	0.567
KIT2		0.617	.779	1.79	1.276	0.939
KIT3		0.703	.694	1.86	1.288	0.856
Root-cause analysis tools	0.684					
RCT1			.537	1.61	1.011	0.594
RCT2			.537	1.65	1.307	0.976
LeanTools	CFI	0,997				
Chi-square = 32,682	IFI	0,997			Visual management tools	0.872
df. = 31	TLI/NNFI	0,994			Pull control tools	0.878
$p = ,384$	NFI	0,943			Kaizen tools	0.586
	RMSEA	0,017			Root-cause analysis toolsInstr.	0.825

CI-Culture – adapted from Huang, Rode & Schroeder (2011)

Range: strongly disagree – strongly agree (5-point Likert scale)

CI1 management is actively engaged in continuous improvement.

CI2 there is a culture of continuous improvement.

CI3 continuous improvement is an important value that characterizes our culture.

Table A.3. Reliability and item statistics CI-Culture

	Cronbach alpha for scale	Alpha if item deleted	Item-to-total correlation	Mean	SD
CI-Culture	.75				
CI1		.77	.48	3.76	.81
CI2		.63	.62	3.20	.97
CI3		.56	.67	3.14	1.04

**A.3. Lean Championship and improvement stimulation by management**

Lean Championship – adapted from Flynn et al. (1999) and Douglas & Judge (2001).

Range: *strongly disagree – strongly agree (5-point Likert scale)*

- LC1 upper management is a true ambassador of Operational Excellence / Lean management.  
 LC2 upper management shows championship to implement Operational Excellence / Lean management.  
 LC3 upper management advocates the use of the principles of Lean management.

Improvement stimulation – adapted from Flynn et al. (1999)

Range: *strongly disagree – strongly agree (5-point Likert scale)*

- IS1 we receive timely feedback from management as we put forward ideas for improvement.  
 IS2 bringing forward suggestions for improvement is actively encouraged by management.  
 IS3 direct staff is actively involved in minor improvements.  
 IS4 higher management actively encourages employees to continuously improve their work.  
 IS5 direct staff is actively involved in major improvement projects (consisting of several improvement workshops).

Table A.4. Reliability and item statistics for first order measurement model of Lean Championship and improvement stimulation by management ( $\chi^2 = 24.064$ ,  $df = 13$ ,  $p = .031$ , CFI = .964, IFI = .966, TLI/NNFI = .922, NFI = .928, RMSEA = .070).

	Cronbach alpha for scale	Alpha if item deleted	Item-to- total correlation	Mean	SD	Item loadings	Average Variances Extracted
Lean Championship	.67						.45
LC1		.65	.44	2.88	1.42	.54	
LC2		.50	.54	2.82	1.08	.86	
LC3		.58	.48	3.28	1.14	.55	
Improvement stimulation improvement tools	.78						.47
IS1		.77	.44	3.36	.86	.58	
IS2		.71	.63	3.75	.89	.77	
IS3		.73	.55	3.71	.96		
IS4		.71	.64	3.76	.87	.83	
IS5		.76	.50	3.32	1.07	.50	

## A.4. Transformational Leadership (TL) – Rafferty &amp; Griffin (2004)

TL: Vision

Range: *strongly disagree – strongly agree (5-point Likert scale)*

TLV1 Upper management has a long-term vision.

TLV2 Upper management has a clear sense of where he/she wants our organization to be in 5 years.

TLV3 Upper management has a clear understanding of where we are going with our organization.

TLV4 Upper management has no idea where the organization is going (R) – not included in the final scale.

TL: Inspiring communication

Range: *strongly disagree – strongly agree (5-point Likert scale)*

TLIC1 Upper management says things that make employees proud to be a part of this organization.

TLIC2 Upper management encourages people to see changing environments as situations full of opportunities.

TL: Intellectual stimulation

Range: *strongly disagree – strongly agree (5-point Likert scale)*

TLIS1 Upper management has challenged me to rethink some of my basic assumptions about my work.

TLIS2 Upper management has ideas that have forced me to rethink some things that I have never questioned before.

TLIS3 Upper management challenges me to think about old problems in new ways.

TL: Supportive leadership

Range: *strongly disagree – strongly agree (5-point Likert scale)*

TLS1 Upper management behaves in a manner which is considerate of my personal needs.

TLS2 Upper management sees that the interests of employees are given due consideration.

TLS3 Upper management considers my personal feelings before acting.

TL: Personal recognition

Range: *strongly disagree – strongly agree (5-point Likert scale)*

TLP1 Upper management commends me when I do a better than average job.

TLP2 Upper management personally compliments me when I do outstanding work.

TLP3 Upper management acknowledges improvement in my quality of work.

Table A.5. Reliability and item statistics for first order measurement model of Transformational Leadership ( $\chi^2 = 132.262$ ,  $df = 67$ ,  $p = .000$ , CFI = .948, IFI = .950, TLI/NNFI = .919, NFI = .903, RMSEA = .070).

	Cronbach alpha for scale	Alpha if item deleted	Item-to- total correlation	Mean	SD	Item loadings	Average Variances Extracted
TL: Vision	.85						.69
TLV1		.76	.75	3.80	.99	.87	
TLV2		.72	.79	3.56	1.04	.87	
TLV3		.86	.64	3.82	.87	.70	
TL: Inspiring communication	.68						.51
TLIC1			.52	3.7	.94	.69	
TLIC2			.52	3.9	.84	.74	
TL: Intellectual stimulation improvement	.82						.61
TLIS1		.78	.65	3.7	.63	.76	
TLIS2		.77	.65	3.5	.64	.77	
TLIS3		.71	.72	3.6	1.00	.82	
TL: Supportive leadership	.77						.53
TLS1		.63	.45	3.6	.86	.77	
TLS2		.72	.49	3.6	.89	.69	
TLS3		.70	.53	3.5	.93	.72	
TL: Personal recognition	.78						.56
TLP1		.71	.61	3.73	.80	.72	
TLP2		.63	.68	3.84	.92	.79	
TLP3		.75	.57	3.41	.89	.73	



**A.5. Servant Leadership (SL) – Nuijten & Van Dierendonck (2011)**

SL: Empowerment

*Range: strongly disagree – strongly agree (5-point Likert scale)*

SLE1 Upper management gives us the information to do our work well.

SLE2 Upper management gives us the authority to take decisions which make work easier.

SLE3 Upper management encourages us to use our talents.

SLE4 Upper management helps me to further develop myself.

SLE5 Upper management enables us to solve problems instead of just telling us what to do – *not included*.

SLE6 Upper management offers abundant opportunities to learn new skills.

SL: Humility

*Range: strongly disagree – strongly agree (5-point Likert scale)*

SLH1 Upper management learns from the different views and opinions of others.

SLH2 Upper management learns from criticism.

SLH3 Upper management is open about their limitations and weaknesses.

SLH4 If people express criticism, upper management tries to learn from it.

SLH5 Upper management is prepared to express their feelings.

SLH6 Upper management admits mistakes.

SL: Standing back

*Range: strongly disagree – strongly agree (5-point Likert scale)*

SLS1 Upper management appears to enjoy subordinate's success more than their own success.

SLS2 Upper management stays in the background and gives credits to others.

**Table A.6. Reliability and item statistics for first order measurement model of Servant Leadership ( $\chi^2 = 115.138$ ,  $df = 62$ ,  $p = .000$ , CFI = .956, IFI = .957, TLI/NNFI = .936, NFI = .912, RMSEA = .066).**

	Cronbach alpha for scale	Alpha if item deleted	Item-to- total correlation	Mean	SD	Item loadings	Average Variances Extracted
SL: Humility	.92						.61
SLH1		.91	.79	3.59	.96	.80	
SLH2		.90	.82	3.54	.90	.82	
SLH3		.91	.76	3.39	1.02	.74	
SLH4		.90	.82	3.50	.88	.87	
SLH5		.91	.73	3.29	.96	.70	
SLH6		.91	.75	3.28	.85	.75	
SL: Empowerment	.81						.47
SLE1		.79	.52	3.83	.80	.59	
SLE2		.79	.53	4.19	.66	.60	
SLE3		.77	.60	4.07	.75	.72	
SLE4		.73	.69	3.80	.92	.83	
SLE6		.76	.63	4.00	.74	.67	
SL: Standing back	.69						.56
SLS1			.53	3.39	1.01	.88	
SLS2			.53	2.93	.86	.59	

**A.6. Empowering Leadership (EL) – Arnold et al. (2000)**

EL: Informing

*Range: strongly disagree – strongly agree (5-point Likert scale)*

- ELI1 Upper management clearly explains company decisions.  
 ELI2 Upper management clearly explains company goals.  
 ELI3 Upper management explains rules and expectations.  
 ELI4 Upper management explains decisions and actions.

EL: Leading by example

*Range: strongly disagree – strongly agree (5-point Likert scale)*

- ELL1 Upper management sets a good example how to behave.  
 ELL2 Upper management leads by example.

EL: Participative decision making

*Range: strongly disagree – strongly agree (5-point Likert scale)*

- ELP1 Upper management encourages employees to express ideas/suggestions.  
 ELP2 Upper management listens to ideas and suggestions from subordinates.  
 ELP3 Upper management gives all employees a chance to voice their opinions.  
 ELP4 Upper management considers ideas from employees even when they disagree.

EL: Showing concern / Interacting with the Team

*Range: strongly disagree – strongly agree (5-point Likert scale)*

- ELS1 Upper management takes the time to discuss subordinate's concerns patiently.  
 ELS2 Upper management stays in touch and gets along with all his/her subordinates.  
 ELS3 Upper management finds time to chat with employees.

**Table A.7. Reliability and item statistics for first order measurement model of Servant Leadership ( $\chi^2 = 125.418$ ,  $df = 45$ ,  $p = .000$ ,  $CFI = .950$ ,  $IFI = .952$ ,  $TLI/NNFI = .923$ ,  $NFI = .912$ ,  $RMSEA = .075$ ).**

	Cronbach alpha for scale	Alpha if item deleted	Item-to- total correlation	Mean	SD	Item loadings	Average Variances Extracted
EL: Informing	.87						.63
ELI1		.79	.81	3.72	.86	.88	
ELI2		.83	.73	3.67	.87	.83	
ELI3		.83	.71	3.57	.87	.76	
ELI4		.87	.62	3.79	.85	.68	
EL: Leading by example	.90						.83
ELL1			.82	3.49	.96	.91	
ELL2			.82	3.53	.91	.91	
EL: Participative decision making	.80						.50
ELP1		.74	.62	3.88	.79	.75	
ELP2		.71	.69	3.90	.77	.78	
ELP3		.76	.60	3.76	.75	.67	
ELP4		.78	.55	3.39	.86	.61	
EL: Showing concern	.71						.46
ELS1		.62	.54	3.87	.79	.66	
ELS2		.66	.49	3.52	.96	.72	
ELS3		.57	.56	2.23	.97	.66	

**A.7. Contingent Punishment Behavior – Podsakoff et al. (1984)***Range: strongly disagree – strongly agree (5-point Likert scale)*

- CPB1 Upper management shows displeasure when work is below acceptable standards.  
 CPB2 Upper management lets us quickly know when performance is poorly.  
 CPB3 Upper management would reprimand subordinates if the work was below standard.  
 CPB4 When my work is not up to par, my manager points it out to me.

**Table A.8. Reliability and item statistics for first order measurement model of T Contingent Punishment Behavior ( $\chi^2 = 8.431$ ,  $df = 2$ ,  $p = .015$ , CFI = .982, IFI = .982, TLI/NNFI = .908, NFI = .977, RMSEA = .127).**

	Cronbach alpha for scale	Alpha if item deleted	Item-to- total correlation	Mean	SD	Item loadings	Average Variances Extracted
Contingent Punishment Behavior	.87						.62
CPB1		.85	.67	3.78	.76	.72	
CPB2		.83	.74	3.64	.88	.79	
CPB3		.83	.74	3.72	.78	.81	
CPB4		.82	.75	3.50	.83	.83	

**A.8. Trust in/Loyalty to the Leader – Podsakoff et al. (1990)***Range: strongly disagree – strongly agree (5-point Likert scale)*

- TLL1 I feel quite confident that upper management will always try to treat me fairly.  
 TLL2 I have complete faith in the integrity of upper management.  
 TLL3 I have a clear sense of loyalty toward upper management.  
 TLL4 I would support upper management in almost any situation.

**Table A.9. Reliability and item statistics for first order measurement model of Trust in/Loyalty to the Leader**

	Cronbach alpha for scale	Alpha if item deleted	Item-to- total correlation	Mean	SD	Item loadings	Average Variances Extracted
Trust in/Loyalty to the Leader	.81						.52
TLL1		.85	.67	3.79	.90	.93	
TLL2		.83	.74	3.99	.83	.88	
TLL3		.83	.74	4.26	.58	.51	
TLL4		.82	.75	3.99	.70	.42	



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