The role of lean leadership in the lean maturity – second-order problem solving relationship: a multiple case study

Arie Bijl, Kees Ahaus and Gwenny Ruël,

Faculty of Economics and Business
University of Groningen, The Netherlands

Paul Gemmel
Department of Innovation, Entrepreneurship and Service Management
Ghent University, Belgium

Bert Meijboom
Department of Tranzo
Tilburg University, the Netherlands

Abstract

This paper investigates the relationships between Lean adoption and the problem-solving behaviour of nurse teams. We explore practices of Lean leaders in hospital settings and discover how leaders can stimulate second-order problem solving within nurse teams. Fourteen nurse teams, with different Lean maturity, were studied empirically through semi-structured interviews. The results indicated a positive relationship between Lean maturity and second-order problem solving, as well as a potential strengthening effect of Lean leadership on this relationship. Also, we identified seven Lean leadership practices in hospital settings that have a strong link with transformational leadership.

Keywords: Lean leadership, Lean maturity, second-order problem solving

Introduction

Some of its earliest applications of Lean thinking in the healthcare sector were more than a decade ago. Since then, Lean has gained in popularity (Mazzocato et al., 2012). The primary goals of Lean in healthcare have been to increase the quality of care and to increase efficiency (Kaltenbrunner et al., 2017). To achieve these goals, most organisations have emphasised the application of Lean tools to reduce direct waste, but neglected developing the problem-solving abilities of front-line employees (Meijboom et al., 2016). This approach may have created some process improvements, but long-term hospital-wide benefits were rarely attained (Burgess and Radnor, 2012).

To realise Lean's higher potential, it is often suggested that structured problem solving should be developed throughout the organisation to improve processes in a sustainable way (Meijboom et al., 2016; Aij et al., 2015). One well-known and effective approach to solving problems is *second-order problem solving*. This involves an in-depth questioning of work practices to discover and remove the root causes of problems (Tucker and Edmonson, 2003). This approach is in sharp contrast with *first-order problem solving* where problems are resolved in an ad-hoc manner, while underlying causes remain (Mazur and Chen, 2009). A recent study by Meijboom et al. (2016)

suggested that second-order problem solving was more prevalent than first-order problem solving in nurse teams with high levels of Lean maturity. However, evidence from a larger sample of wards is needed.

Earlier studies have suggested that hospital leaders could stimulate the second-order problem-solving behaviour of nurses (Tucker and Edmondson, 2003). Leaders are crucial to create and sustain the benefits of Lean adoption in hospitals wards, since they can help to create a culture of continuous improvement, empower employees and foster participation (Aij and Teunissen, 2017; Poksinska et al., 2013). Although the importance of Lean leaders is often emphasised in literature, there are few empirical studies of Lean leadership in healthcare. Moreover, most studies have not connected Lean leadership with other leadership theories (Poksinska et al., 2013).

This paper studies the relationship between Lean maturity and second-order problem solving. We explore the meaning attached to Lean leadership in a hospital setting and discover how this moderates the Lean maturity – second-order problem solving relationship in nursing wards. Hence, we answer the following research questions:

- How does Lean maturity affect the problem-solving behaviour of nurse teams?
- What comprises Lean leadership in a hospital setting?
- How does Lean leadership affect the relationship between Lean maturity and second-order problem solving?

Background

Lean maturity

The concept of Lean maturity needs consideration to examine accurately the impact of Lean implementation on the problem-solving behaviour of nurse teams (Meijboom et al., 2016). According to Malmbrandt and Åhlström (2013), the extent of Lean adoption in an organisation can be measured using an instrument that incorporates measures to assess Lean enablers, Lean practices and performance. Lean enablers represent the supporting structure or preconditions of Lean, including the training of employees and dedication of time and resources for improvement work. Lean practices correspond to Lean principles, such as continuous improvement and eliminating waste. Performance refers to the results of Lean adoption in measures, such as quality, customer satisfaction and costs. Together, these three dimensions determine the Lean maturity level in an organisation. These can range from no adoption, to an exceptional, well-defined and innovative approach (Malmbrandt and Åhlström, 2013).

Second-order problem solving

Nurses play an essential role as front-line service providers. They are in the best position to discover and eliminate root causes of problems and, thereby, help their organisation learn (Tucker and Edmondson, 2003; Mazur and Chen, 2009). Second-order problem solving occurs when: “the worker, in addition to patching the problem so that the immediate task at hand can be completed (i.e. first-order problem solving), also takes action to address underlying causes” (Mazur and Chen, 2009, p.63).

Tucker and Edmondson (2003, p.61) distinguish five broad actions of second-order problem solving: (1) communicating to the person or department responsible for the problem, (2) bringing the problem to the manager’s attention, (3) sharing ideas about the cause of the situation and how to prevent recurrence, (4) implement changes, and (5) verify that changes have the desired effect.

Nurses often apply first- and second-order problem-solving approaches. Quick workarounds may be needed if patients cannot wait for the promised care (Tucker, 2009). Only by applying second-order problem solving can real process improvements

be obtained. Meijboom et al. (2016) even state that a learning organisation based on second-order problem solving is one of the ultimate goals of Lean.

Lean leadership

The importance of effective 'Lean leadership' during Lean implementations is widely recognised and the term increasingly mentioned in literature (Aij and Teunissen, 2017). Past studies in healthcare have suggested that Lean leadership can be connected with transformational leadership theory (Van Rossum et al., 2016; Poksinska et al., 2013). Through transformational leadership, followers are motivated to do more than originally expected and feel trust, loyalty, respect and admiration towards their leader (Bass, 1999). A transformational leader develops his followers by employing four key dimensions. *Idealised influence* refers to a leader being a role model, who is admired and respected by his followers. *Inspirational motivation* implies that a leader motivates those around him/her and arouses their spirit. Transformational leaders use *intellectual stimulation* to stimulate their followers' efforts to be innovative and creative. Finally, a transformational leader pays attention to the need for achievement and growth of individuals through *individual consideration* by acting as a coach (Bass, 1999). Transformational leadership is different from transactional leadership. The latter is merely an exchange process to motivate follower compliance, where a leader clarifies performance criteria, states expectations and determines what followers receive in return (Bass, 1999).

Despite suggestions of a link between Lean leadership and transformational leadership theory, there are few empirical studies investigating Lean leadership in healthcare (e.g. Goodridge et al., 2015; Poksinska et al., 2013). Hence, in order to clarify this concept, an in-depth empirical study of Lean leaders in hospital settings is needed.

Conceptual model

Figure 1 displays the conceptual model of this study. First, in line with Meijboom et al. (2016), we expect higher Lean maturity can lead to an elevated degree of second-order problem solving of nurse teams. Second, since Lean leaders are seen as essential in enhancing the problem-solving abilities of healthcare staff (Aij and Teunissen, 2017), we expect effective Lean leadership could strengthen the relationship between Lean maturity and second-order problem solving.

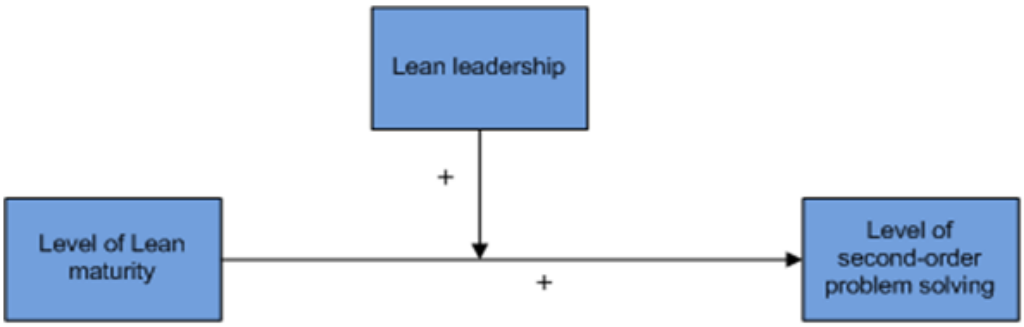

Figure 1 - Conceptual model

Methodology

This research comprises 14 case studies of nurse teams in different departments of a Dutch hospital; each in various phases of a Lean-based quality improvement programme - 'The Productive Ward – Releasing Time to Care' (now referred to as PW). This programme teaches nurse teams how to apply Lean tools and principles in their daily work and claims to increase the time nurses have for direct patient care (White et al., 2014). A key tool incorporated in PW is the Hairdryer model. This teaches nurses to engage in effective problem solving by discussing problems in groups, mapping the current situation, collecting data, implementing changes and assessing their impacts.

There is a PW core team for each of the 14 nurse teams that leads the change. Generally, this consists of one team leader and a few nurses. To obtain reliable data, the team leader, one nurse inside and one nurse outside each PW core team were interviewed. Nurse teams with differing lengths in the programme (0-24 months) were selected as cases. We expected this to provide us with variation on the Lean maturity variable. Cases with different levels of durations were selected to produce different results, but for predictable reasons (i.e. theoretical replication, Karlsson, 2009). Table 1 shows the selected cases within each duration level.

Table 1 - Selected cases within each duration level

Duration	Selected cases
Level 1 (0-6 months)	L, N
Level 2 (6-12 months)	H, I, J, K
Level 3 (12-18 months)	D, E, F, G, M
Level 4 (18-24 months)	B, C
Level 5 (24 + months)	A

Data collection

In total, 43 semi-structured interviews were conducted in December 2016 with an average duration of 40 minutes, a minimum of 24 minutes and a maximum of 68 minutes. Multiple researchers were present at all interviews. The interview questions related to Lean maturity measured several Lean enablers and Lean practices. These provided accurate insight into the progress made during Lean implementation. These enablers and practices of Lean were extracted from Malmbrandt and Åhlström's instrument. This originally contains 34 items to assess Lean service adoption. We decided to include only six items for several reasons. First, accurate and reliable performance data was lacking in most departments. This forced us to exclude all performance-oriented items. Furthermore, certain items had strong links with other main variables, such as management commitment and understanding (Lean leadership) and the degree of structured problem solving (second-order problem solving). Last, some items were not considered relevant, or else too complex, to measure (e.g. levelling and balancing of workloads). The customised instrument resulted in selecting three Lean enablers (employee understanding of Lean; time and resources allocated to improvement work; bi-directional vertical information flow), and three Lean practices (identification of patient value, workplace design for flow; and visualisation of information and improvements).

Second-order problem solving was measured through a set of questions in the form of scenarios derived by Meijboom et al. (2016). These scenarios describe several types of problems nurses face in their daily work. They were used to obtain information about the actions nurses took when faced with a problem. Nurses were also asked to provide

examples of a problem where they engaged in second-order problem solving so we could obtain more insights into this concept.

Lean leadership was studied from multiple views using different open and semi-structured interview questions asked to team leaders and nurses.

Data analysis

Multiple researchers conducted the coding of interviews to enhance the reliability of the findings (Karlsson, 2009). For each interview, scores were given for the level of Lean maturity and second-order problem solving, based on the instruments used. Each score was given by multiple respondents and checked for consistency. This process eventually resulted in a low, medium or high score of the Lean maturity and second-order problem-solving variables for each team.

A correlation analysis was performed to find out whether the duration of the PW programme corresponded with the level of Lean maturity. This revealed a correlation ($r = 0.58$; $p < 0.001$). Next, the three enablers and three practices of Lean were classified into five-point scales based on the instrument of Malmbrandt and Åhlström (2013). Although the Lean enablers and practices were extracted from a validated instrument, a confirmatory factor analysis (CFA) was needed to test the unidimensionality of the six selected items. The CFA extracted one component with all factor loadings higher than 0.7, indicating construct validity of Lean maturity, by measuring the six items. In addition, the reliability analysis returned a Cronbach's alpha of 0.84. This points to a strong internal consistency of the Lean enablers and practices.

The information collected through the scenarios was used to link each respondent to one of the categories of first- and second-order problem solving in a scale with eight levels. Levels 1, 2 and 3 represent first-order problem-solving approaches, whereas levels 4 through 8 represent second-order problem-solving actions of Tucker and Edmondson (2003, p.61). Thus, a higher level in this scale indicates a higher degree of second-order problem solving.

For the within-case analysis of Lean leadership, all interviews were analysed to extract useful data. Using the step-by-step approach of Gioia et al. (2013), the data were coded inductively by two researchers. This led to a coding tree of Lean leadership practices (available on request) involving 339 *in vivo* codes, 29 themes and seven aggregate dimensions. The list of themes was used by two researchers to code nine interviews independently (20% of the interviews). A comparison demonstrated an acceptably high inter-rater reliability of the meaning of Lean leadership with a Krippendorff's alpha value of 0.85 (Krippendorff, 2004).

In the cross-case analysis, cases with anticipated low, medium and high levels of Lean maturity and second-order problem solving were compared with deviating cases to determine how Lean leadership strengthened the relationship between Lean maturity and second-order problem solving.

Results

The results demonstrated that Lean maturity positively influenced the level of second-order problem solving of nurse teams. This relationship was tested through a single linear regression analysis. A highly significant positive relationship between Lean maturity and second-order problem solving was found, $\beta = 0.68$, $R^2 = 0.46$, $p < 0.001$.

Within-case analysis

The in-depth analysis of the meaning of Lean leadership resulted in the identification of seven Lean leadership practices: (1) convincing and setting the example, (2) unlocking

individual and team potential, (3) solving problems systematically, (4) enthusing, actively participating and visualising, (5) developing self-managing teams, (6) sensing, as orchestrator, what is needed for change and (7) listening, sharing information and appreciating. Each of these practices is explained below.

First, Lean leaders helped nurses to become acquainted with the programme. They are the driving force of PW by setting an example and actively promoting PW in their team. Early on many nurses needed to be convinced of the value of PW. So, an important activity was to explain PW modules and point out potential benefits, such as the time that could be saved by applying PW: *"I try to give insights into why we have to change certain things"* (D-01, team D, participant '01' refers to the team leader; '02' and '03' refer to a nurse in and outside the PW core team respectively).

Lean leaders also aimed to unlock a higher potential of nurses and their team by encouraging everyone to become active within PW. For instance, by stimulating membership of the PW core team and participation during improvement board sessions. Nurses were also invited to indicate a preferred improvement project to work on within PW, based on their own interests and capabilities. Within these PW projects, Lean leaders adjusted their degree of involvement for each individual, based on the level of experience of nurses. This gave room for individual potential to develop.

Furthermore, Lean leaders were involved in systematic problem solving. They were present during team discussions where problems were analysed by applying PW tools. Leaders also encouraged their team to solve problems through the Hairdryer model, as they felt that this model should be incorporated into nurses' work practices. In addition, the leaders provided cooperation to nurses that wanted to engage in systematic problem solving, as one of the participants stated: *"Our team leader would help us by providing input on how we can approach things"* (C-03).

Another key Lean leadership practice was to enthuse the team, actively participate in PW and visualise. First, the leaders encouraged nurses to organise improvement board sessions and to perform daily evaluations of processes. We observed that team members were regularly switched, as being a member of the PW core team was perceived as a great motivating factor by nurses. Second, the leadership involvement was seen as highly important by nurses and leaders themselves, as the following quotes illustrate: *"The leader motivates me through her enthusiasm, and by showing that she wants it herself"* (N-02) and: *"I need to bring along the group through enthusiasm"* (E-01). Finally, many participants expressed that leaders used visualisation through photos or videos to create awareness of a non-optimal situation and to demonstrate PW accomplishments.

Lean leaders also developed self-managing teams. They encouraged nurses to take the lead actively, for instance, by giving ownership to nurses for improving certain processes through PW tools. It was frequently noted that, as the implementation of PW progressed, Lean leaders increasingly relinquished tasks and responsibility to increase the sense of ownership among the nurses in the team. This is supported by the following quotes: *"Through this programme, my tasks are diminished as nurses themselves take more responsibility"* (A1-01) and *"The leader does not want to keep tight control of everything, he relinquishes tasks and gives guidance, which motivates us to be actively involved in the programme"* (H-03).

Lean leaders continuously thought about what was needed for the change. For instance, they facilitated by giving time and resources to engage in PW activities and they made sure that PW meetings took place on a regular basis. It was also stated that the leaders provided direction and kept the overview of PW's progress within their team, without losing track of the hospital's objectives. The leaders focused on small and

manageable steps to improve within the PW modules, carefully assessed resistance to PW from the team and gave constant attention to assure the changes.

Finally, Lean leaders took time to listen, share information and appreciate. They engaged in individual conversations with nurses in order to stay involved and, if there were issues within the team, to better understand why these had emerged. Information about PW's progress was also shared actively with the team using score charts, newsletters and e-mails: *"It is my responsibility to inform them properly"* (K-01). Lean leaders also expressed appreciation to their team. Compliments were given if the team was on schedule and when certain modules had been completed successfully.

Cross-case analysis

Figure 2 displays the levels of Lean maturity and second-order problem solving of each case. The blue lines represent the actual outcomes for each case, whereas the red line shows the expected line of second-order problem solving, given the Lean maturity level, and based on the proposition that Lean maturity positively influences second-order problem solving.

The graph shows that not all cases corresponded with the proposition. To search for patterns, cases that agreed with the proposition were compared to cases that deviated. This was analysed in order to determine whether the difference in second-order problem-solving levels could be ascribed to practices of Lean leaders. More specifically, cases C and D (medium Lean maturity – low second-order problem solving i.e. 'ML') were compared with cases E, G, J, M (medium Lean maturity – medium second-order problem solving, i.e. 'MM'). Also, cases B and H (high Lean maturity – medium second-order problem solving, i.e. 'HM') are compared with case A (high Lean maturity – high second-order problem solving, i.e. 'HH').

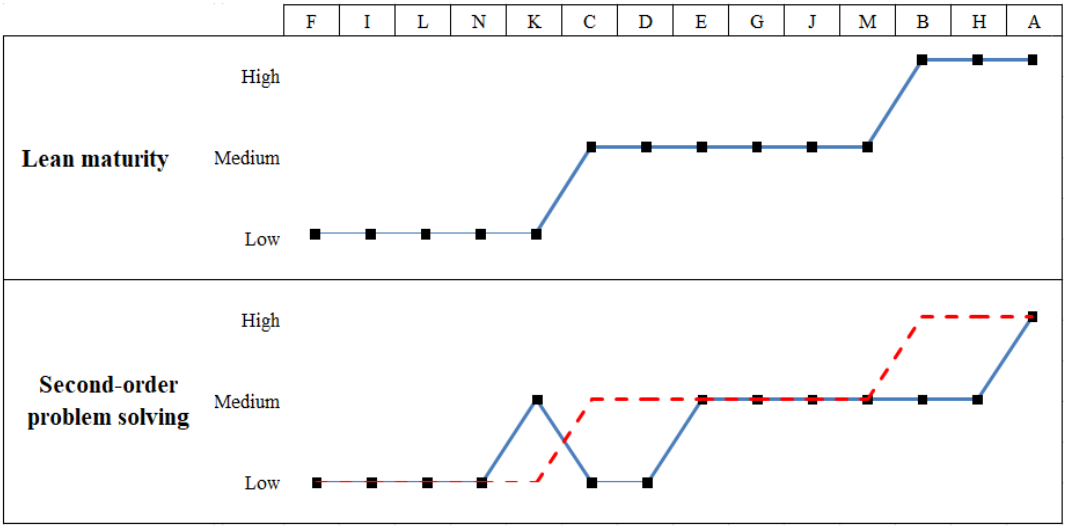

Figure 2 – Lean maturity levels & expected (dotted in red) and actual (blue) second-order problem-solving level per case

Our analysis shows that Lean leaders could contribute to a high level of second-order problem solving in their team. Second-order problem solving can be increased by leadership practices that encourage team ownership in the problem-solving process. In HH cases, the leaders played a crucial role in empowering and stimulating nurses to take the lead in thinking about solutions to problems and in implementing solutions through a bottom-up approach. In HH teams, this was stated as follows: *"Solutions to*

problems are not imposed upon us, we think about them ourselves" (A2-03) and *"She tells me to go and investigate how I could make a solution happen"* (A1-03). In HM cases, most teams were self-managed, but responsibility over the entire problem-solving process had not been completely relinquished by the leaders. Hence, more interference and active support of the leaders in the problem-solving process was observed.

Second, our analysis shows that the presence of an enthusiastic leader that actively participated in the Lean initiative as a role model can lead to a higher level of second-order problem solving. In HH and MM teams, the leaders were seen as role models of PW through their enthusiasm and participation, as exemplified by the following quote: *"Our leader is very enthusiastic and fanatic"* (E-02). This was perceived as an important aspect that keeps PW alive in the team and, thereby, keeps nurses motivated to participate. In contrast, in HM and ML cases, the level of enthusiasm and participation from leaders was perceived as being much lower.

Discussion

The first main research question posed in this research was: *How does Lean maturity influence the problem-solving behaviour of nurse teams?* Our findings confirm the proposition that, as nurse teams reached higher levels of Lean maturity, they also demonstrated higher degrees of second-order problem solving. Thereby, stronger evidence was established for the existence of a positive relationship between Lean maturity and second-order problem solving (Meijboom et al., 2016). This suggests that nurses may become more skilled problem-solvers through Lean implementation (Mazur et al., 2008; Spear, 2005). The reason is that Lean helped nurses to become acquainted with the identification, analysis and removal of root causes of problems. In our study, nurse teams were trained to use the Hairdryer model involving multiple activities in line with second-order problem-solving actions (Tucker and Edmondson, 2003).

The second question was: *What comprises Lean leadership in a hospital setting?* In order to answer this question adequately, Lean leadership has been studied empirically in multiple nurse teams, resulting in the identification of seven Lean leadership practices as listed in the within case analysis section above. Overall, our findings indicate that Lean leadership in healthcare has a strong connection with transformational leadership theory, in line with earlier studies (Van Rossum et al., 2016; Poksinska et al., 2013).

Many identified Lean leadership practices can be classified as transformational. For example, arousing the team spirit through motivation and inspiration are key activities in the inspirational motivation dimension (Bass, 1999). Also, charismatic-inspirational leadership was exercised when Lean leaders enthused others and, at the same time, actively participated in the Lean programme themselves (Stone et al., 2004). A further connection with individualised consideration and coaching to develop followers was observed in Lean leaders' practice of unlocking individual and team potential. This was done by recognising differences between individual qualities and preferences within the team (Stone et al., 2004). Our results indicate that Lean leaders also used transformational practices, such as listening effectively, active information sharing and appreciating people (Stone et al., 2004). We also found a strong connection with existing Lean leadership literature. Our results underpin the importance of visualisation within hospital environments (Drotz and Poksinska, 2014; Poksinska et al., 2013). Visualisation was practiced by Lean leaders to help the team identify areas for improvement and to demonstrate PW accomplishments on improvement boards throughout the ward.

The final question was: *How does Lean leadership affect the relationship between Lean maturity and second-order problem solving?* The cross-case analysis revealed that Lean leaders increasingly relinquished responsibility for improvement activities to the team as Lean maturity increased. At the outset of Lean initiatives, large investments from leaders were required in terms of effort and resources (Poksinska et al., 2013) and a top-down direction initially may be necessary to create the supporting structure for Lean (Taher et al., 2016). However, in later stages, it was imperative to empower front-line staff to take the initiative in daily improvement activities (Goodridge et al., 2015). Our findings suggest that this transition was necessary for nurse teams to reach a high level of second-order problem solving. Lean leaders have an important role to facilitate this transition by encouraging nurses to take ownership over improvement activities and by developing their team to become self-managing. The importance of stimulating a bottom-up approach to continuous improvement in healthcare is supported by existing literature (Spear, 2005; Drotz and Poksinksa, 2014).

Overall, our findings suggest that Lean implemented in nurse teams required a bottom-up approach with gradually increasing responsibility for improvement activities of nurses in the front line, supported by leaders with strong transformational leadership skills that radiated enthusiasm towards their team. Through this, nurse teams may reach a high second-order problem-solving level as Lean matures.

This study has a number of limitations. First, since nurse teams of only one Dutch hospital were included, the external validity of our findings could be impacted negatively. Second, a limitation is that many respondents did not recognise all problems from the scenarios of Meijboom et al. (2016). This was counteracted at an early stage of data collection by asking an additional open-ended question as to whether nurses could provide an example of a problem solved through a second-order problem-solving approach. This resulted in many useful responses.

Future research could aim to measure second-order problem solving in nurse teams and benefit from this approach. This adds new scenarios where nurses can recognise their problem-solving behaviour. Future research aiming to measure Lean maturity in healthcare may benefit from a new validated scale involving six items of Malmbrandt and Ahlström's (2013) instrument relevant to and measurable in nursing wards.

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