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**LIDERANÇA EM SISTEMAS DE
PRODUÇÃO ENXUTA: CONCEITO,
COMPETÊNCIAS E INFLUÊNCIA DO
CONTEXTO**

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Porto Alegre

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Tese submetida ao Programa de Pós-Graduação em Engenharia de Produção da Universidade Federal do Rio Grande do Sul como requisito parcial à obtenção do título de Doutor em Engenharia, na área de concentração em Sistemas de Produção.

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Esta tese foi julgada adequada para a obtenção do título de Doutor em Engenharia de Produção e aprovado em sua forma final pelo Orientador e pela Banca Examinadora designada pelo Programa de Pós-Graduação em Engenharia de Produção da Universidade Federal do Rio Grande do Sul.

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RESUMO

Embora seja reconhecido que a liderança em um Sistema de Produção Enxuta (SPE), neste estudo denominada como liderança *lean*, seja influenciada pelo contexto que a envolve, os mecanismos ligando os fatores de contexto à liderança ainda não foram devidamente explorados. Esta tese tem como objetivo principal a proposição de um método para a análise da influência do contexto sobre as competências de liderança requeridas em um SPE. Tendo em vista este objetivo, também foi necessário lidar com outra lacuna da literatura, que é a identificação das competências que diferenciam uma liderança tradicional da liderança *lean*. Assim, os objetivos específicos deste estudo são: (i) investigar como as teorias gerais de liderança podem contribuir para a expansão do conhecimento sobre a liderança *lean* e (ii) identificar e validar as competências de liderança *lean*. A abordagem norteadora da tese é a *Design Science Research* (DSR) que, com sua natureza prescritiva, busca desenvolver o conhecimento por meio da construção de artefatos. A tese está estruturada em três artigos: (i) “*Leadership in lean production systems: how it is related to general leadership theories*”, que tem como principal objetivo investigar a contribuição das teorias de liderança para o aprofundamento do conhecimento sobre a liderança *lean*; (ii) “*Lean leadership competencies – a multi-method study*”, que tem como principal objetivo identificar e validar as competências de liderança *lean* e (iii) “*The influence of context on lean leadership competencies*” que tem como principal objetivo a proposição e teste do método de análise da influência do contexto sobre as competências de liderança. Desta forma, o último artigo atende o principal objetivo da tese. Esse artigo também apresenta um modelo de quatro tipos de eventos de liderança *lean* (linear, aparentemente linear, aparentemente complexo e complexo), indicando que a liderança *lean* é um fenômeno emergente que exige líderes adaptativos capazes de navegar em um contexto dinâmico.

Palavras-chave: Liderança *lean*, competências de liderança, Teorias de Liderança, contexto, fenômeno emergente

ABSTRACT

Although it is recognized that leadership in a Lean System, in this study named Lean Leadership, is influenced by the context, the mechanisms linking the contextual factors to leadership have not yet been explored. This thesis aims to propose a method to analyze the influence of context on the leadership competencies demanded in a Lean System. Considering this objective, it was also necessary to deal with another literature gap which is the identification of the competencies that differentiate a traditional leadership from the lean leadership. Thus, the specific objectives of the study are: (i) investigate how the general leadership theories can contribute to the expansion of the knowledge about lean leadership, and, ii) identify and validate the lean leadership competencies. The approach of the thesis is the Design Science Research (DSR) which, with its prescriptive nature, aims to develop knowledge through the construction of artifacts. The thesis is structured in three articles: (i) *“Leadership in lean production systems: how it is related to general leadership theories”*, which has as its main objective investigating the contribution of the general theories to the deepening of the knowledge about lean leadership; (ii) *“Lean leadership competencies – a multi-method study”*, which has the main objective of investigating and validating the lean leadership competencies, and, (iii) *“The influence of context on lean leadership competencies”* which aims at proposing and testing the method to analyze the influence of context on leadership competencies. Having said that, the last article meets the main objective of the thesis. This article also presents a model of four typical lean leadership events (linear, apparently linear, apparently complex, and complex), indicating that lean leadership is an emergent phenomenon that requires adaptive leaders who are capable of navigating across a dynamic context.

Keywords: Lean leadership, leadership competencies, leadership theories, context, complexity

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1. INTRODUÇÃO

1.1. CONTEXTO

O projeto de pesquisa do Massachusetts Institute of Technology (MIT) desenvolvido na década de 80 comparando o modelo de organização das grandes indústrias automobilísticas americanas com o modelo japonês (WOMACK et al., 1991) deu origem ao termo Lean Production (Produção Enxuta) ou simplesmente *lean*. O Sistema Toyota de Produção (STP), referência do modelo japonês, foi definido como um sistema orientado para a redução de custos a partir da eliminação de perdas (MONDEN, 1998; OHNO, 1988; SHINGO, 1989).

Embora as descrições originais do STP abordassem o fator humano, seja como “respeito às pessoas” (MONDEN, 1998) ou pela analogia do esporte com o trabalho em equipe na fábrica (OHNO, 1988), predominaram as abordagens técnicas e muitas empresas viram frustradas as suas tentativas de reproduzir o desempenho da Toyota (EMILIANI e STEC, 2005; SPEAR e BOWEN, 1999). Avançando na compreensão do papel das pessoas no STP, Spear e Bowen (1999) descreveram a essência da Toyota em quatro regras que fazem parte do comportamento de todos os empregados, em todos os níveis.

Segundo Shah e Ward (2007), ao longo do tempo, um Sistema de Produção Enxuta¹ (SPE) tem sido descrito a partir de duas perspectivas complementares: i) uma filosófica, baseada nos princípios e nos objetivos; ii) uma prática, baseada nas ferramentas, práticas e técnicas. Com o objetivo de conectar as perspectivas filosófica e prática, Shah e Ward (2007) definiram um SPE como sendo um sistema sócio-técnico para a eliminação ou redução das perdas a partir da redução da variabilidade interna, de fornecedores e de clientes. Segundo a teoria sócio-técnica, um sistema só funciona satisfatoriamente se os aspectos sociais e técnicos forem conectados e analisados de forma interdependente (CLEGG, 2000; BAXTER e SOMMERVILLE, 2011). Assim, para uma organização implementar um SPE é necessário a gestão simultânea dos seus sistemas sociais e técnicos (SHAH e WARD, 2007).

¹O Sistema Toyota de Produção (STP) será referenciado sempre que houver a necessidade de especificar o sistema desenvolvido na Toyota. Quando não houver referência específica à Toyota será utilizado o termo Sistema de Produção Enxuta (SPE).

A compreensão do SPE como um sistema sócio-técnico e não apenas como um conjunto de práticas, tem as seguintes implicações:

- a) O reconhecimento da complexidade que envolve um SPE, uma vez que ele tem impacto em todas as atividades gerenciais e operacionais, de processos internos, fornecedores e clientes. Dessa forma, um SPE envolve interações entre diversos agentes sociais e técnicos, as quais não podem ser completamente controladas (SAURIN et al., 2013);
- b) A implementação de um SPE como uma mudança organizacional. Implantar um SPE é difícil, lento e é necessário que as organizações considerem os aspectos intangíveis da mudança (BHASIN, 2012; NORDIN et al., 2012);
- c) As dificuldades para a implementação de um SPE. Marodin e Saurin (2015b) definem uma barreira na implementação de um SPE como qualquer problema técnico, organizacional ou social que compromete a eficiência e a efetividade do processo. Várias barreiras identificadas no estudo de Marodin, Saurin (2015b) estão relacionadas ao desenvolvimento das pessoas, tais como: i) desmotivação; ii) falta de conhecimento técnico das áreas de apoio (RH, por exemplo); iii) falta de treinamento e iv) falta de apoio da média e alta gerência. Por outro lado, a manutenção das melhorias implementadas, ao longo do tempo, também é foco de estudos (HINES et al., 2008; TAYLOR et al., 2013; ROTH, 2011; STONE, 2012; LUCEY et al., 2005).
- d) O desenvolvimento das pessoas. O relatório *Environmental & Social Report* (TOYOTA, 2004) declara que a Toyota procura desenvolver pessoas através da fabricação de carros. A importância do desenvolvimento de pessoas na Toyota parte da suposição de que estas, cuidadosamente selecionadas e desenvolvidas, irão continuamente melhorar os processos e gerar uma vantagem competitiva para a organização (LIKER e HOSEUS, 2010).

O desdobramento da perspectiva sócio-técnica apresentada anteriormente traz à tona a necessidade de aprofundamento no que tange: (i) ao papel da liderança no processo de implementação do SPE dado que a sua implementação exige que as lideranças desenvolvam novas competências (EMILIANI, 2003) e (ii) à influência dos fatores de contexto sobre a liderança.

Emiliani (2003), argumenta que a implementação de um SPE exige que as lideranças desenvolvam novas competências. Neste sentido, um SPE faz com que a organização assuma

novas características na sua organização do trabalho, como por exemplo, a ênfase do trabalho em equipe e a solução de problemas, o que as diferencia das organizações tradicionais (FORZA, 1996; JENNER, 1998). Liker e Ballé (2013), por sua vez, descrevem que são as competências das lideranças que diferenciam a Toyota das outras empresas. No entanto, muitas publicações sobre liderança em SPEs (LIKER e CONVIS, 2012; SPEAR, 2004) não foram conduzidas como pesquisas acadêmicas e são, na sua maioria, baseadas na experiência dos próprios autores. Outros estudos, embora direcionados para as características da liderança como comportamentos, atitudes, papéis e responsabilidades, (e.g. EMILIANI, 2003; EMILIANI e STEC, 2005; LIKER e BALLÉ, 2013), não apresentam um método de pesquisa verificável para apoiar as suas descobertas.

Assim, algumas lacunas de conhecimento não foram endereçadas a partir de uma abordagem científica. Esta crítica se aplica, por exemplo, à identificação e validação das competências para desempenhar o papel de liderança² em um SPE. Boyatzsis (2008) define uma competência como uma capacidade e a descreve como um conjunto de comportamentos relacionados, embora diferentes, organizados em volta de uma intenção. Os comportamentos são manifestações da intenção, conforme apropriado em várias situações (BOYATZSIS, 2008). De acordo com o mesmo autor, uma competência requer ações e intenções, as quais podem ser inferidas a partir de comportamentos observáveis.

Outra lacuna se refere ao fato de que as pesquisas sobre a liderança *lean* são, na sua maioria, estudos de caso (e.g. LIKER e BALLÉ, 2013; SPEAR, 2004). Isto dificulta generalizações sobre as descobertas relacionadas sobre quais são as características da liderança. Além disso, há uma lacuna de estudos com evidências empíricas ligando o nível de desenvolvimento das competências da liderança com os resultados operacionais.

Por outro lado, embora seja reconhecida a importância da liderança *lean*, os estudos sobre ela não são baseados na literatura disponível sobre teorias de liderança. A liderança como campo de pesquisa existe há mais de 60 anos (YUKL, 2010) e a extensão de como estas teorias de liderança são relevantes para a liderança *lean* ainda não foram devidamente investigadas.

² Para efeito de simplificação, “liderança em um SPE” será referenciada a partir deste ponto no texto como “liderança *lean*”.

Além disso, estudos sobre liderança lean não são normalmente baseados em alguma teoria de liderança, e aqueles que as utilizam, tendem a focar nas teorias da Liderança Transformacional (e.g. FOUND e HARVEY, 2007; STEED, 2012) ou da Liderança Situacional (e.g. TORTORELLA e FOGLIATTO, 2017). Portanto, a extensão na qual as teorias de liderança são relevantes para a liderança *lean* não foi devidamente investigada mesmo que haja evidências indicando que tais teorias são claramente relevantes. Por exemplo, SPEs tem sido desenvolvidos em contextos altamente complexos (e.g. saúde) (SOLIMAN e SAURIN, 2017), os quais podem se beneficiar das percepções decorrentes da teoria de Liderança da Complexidade (UHL-BIEN et al., 2007). Outro exemplo está no estudo do trabalho em equipe desenvolvido no âmbito das teorias de liderança (DINH et al., 2014), o qual é chave em um SPE (MARKSBERRY et al., 2010). Assim, embora os estudos sobre liderança *lean* tenham crescido nos últimos anos, as pesquisas existentes ainda estão fragmentadas e fracamente apoiadas nas teorias de liderança (TORTORELLA et al., 2018; VAN DUN et al., 2017).

1.2. PROBLEMA DE PESQUISA

O papel desempenhado pelo contexto na implementação de um SPE é amplamente reconhecido como relevante, e diversos fatores contextuais foram identificados como importantes, tanto para apoiar como para dificultar a implantação de um SPE (e.g. BROWNING e HEATH, 2009; SHAH e WARD, 2003). Estudos sobre o contexto em SPEs geralmente baseiam-se em *surveys* (SHAH e WARD, 2003; NETLAND, 2016; TORTORELLA et al., 2018).

Independentemente dos resultados estatisticamente generalizáveis destas *surveys*, eles são ilusórios em alguma medida, visto que SPEs possuem contextos únicos que diferenciam cada sistema. Isto ocorre porque empresas que adotam o SPE são sistemas sócio-técnicos complexos, sujeitos a um grande número de elementos em interações dinâmicas influenciadas pelo ambiente externo (SOLIMAN et al., 2018). Além disso, estudos baseados em *surveys* normalmente consideram poucos fatores contextuais, o que não corresponde às dinâmicas complexas que ocorrem em SPEs. Por exemplo, Netland (2016) considerou quatro fatores contextuais (setor de atividade, número de colaboradores, estágio de implementação e cultura do país). Já Shah e Ward (2003), enfatizaram três fatores contextuais (sindicalização, idade da

planta e tamanho da planta). Tortorella et al. (2018), por sua vez, investigaram dois fatores contextuais (tamanho da equipe e idade do líder).

Em contrapartida, no seu estudo de caso, Marodin e Saurin (2015b) identificaram 34 fatores contextuais que influenciaram as barreiras à implementação de um SPE. Tal estudo contrasta com o número de fatores investigados pelas *surveys* supracitadas. Considerando que estes fatores contextuais interagem entre si e não apenas com os princípios e práticas da Produção Enxuta, faz-se necessário um método analítico e holístico para o entendimento teórico e prático desta complexidade.

Enquanto o contexto influencia todas as dimensões de um SPE, este estudo explora a influência nas competências de liderança, as quais são críticas para uma implementação bem sucedida (CAMUFFO e GERLI, 2018; ALAGARAJA, 2014). Embora seja bem estabelecido que as competências de liderança *lean* sejam influenciadas pelo contexto, (CAMUFFO e GERLI, 2018), os mecanismos que ligam o contexto à liderança não são ainda bem compreendidos, e há uma lacuna de dados empíricos resultantes de pesquisas qualitativas.

Baseado nisto, a principal pergunta de pesquisa levantada por este estudo é colocada da seguinte forma: como o contexto influencia as competências de liderança *lean*? Para responder esta pergunta, um método para a análise da influência do contexto nas competências de liderança *lean* foi desenvolvido e testado.

1.3. QUESTÕES E OBJETIVOS DA PESQUISA

A partir da apresentação do contexto e do problema de pesquisa, as questões a que esta tese procura responder são divididas em questão principal e questões secundárias.

1.3.1. Questão principal de pesquisa

Como avaliar a influência do contexto sobre as competências de liderança *lean* ?

1.3.2. Questões secundárias de Pesquisa

- i. Como as teorias gerais de liderança podem ajudar a expandir o conhecimento sobre a liderança *lean*?

- ii. Quais são as competências de liderança *lean*?

A partir das perguntas de pesquisa, podem ser explicitados os objetivos geral e específicos do trabalho.

1.3.3. Objetivo Geral

O objetivo geral da pesquisa é a proposição de um método para a análise do impacto do contexto sobre as competências de liderança *lean*.

1.3.4. Objetivos Específicos

Os objetivos específicos desta pesquisa são:

- i. Investigar sobre como as teorias gerais de liderança podem auxiliar para a expansão do conhecimento sobre a liderança *lean*;
- ii. Identificar e validar as competências de liderança *lean*.

1.4. ESTRATÉGIA DE PESQUISA

Este estudo está enquadrado como uma aplicação da *Design Science Research* (DSR), a qual envolve o desenvolvimento de um artefato inovador para resolver um problema prático e, simultaneamente, produzir uma contribuição científica (HOLMSTRÖM et al., 2009). A DSR tem sido considerada uma abordagem epistemológica relevante para preencher as lacunas entre teoria e prática no campo da gestão de operações (VAN AKEN et al., 2016). Os cinco produtos típicos da DSR são (MARCH e SMITH, 1995): (i) constructos, que são os conceitos chave para caracterizar um problema ou uma solução; (ii) modelos, que correspondem à combinação de constructos a fim de descrever as interações entre tarefas, situações ou artefatos; (iii) métodos, que são as formas de realizar as atividades voltadas aos objetivos; (iv) instanciações, que correspondem à realização do artefato em um ambiente e; (v) contribuições teóricas em termos de construção metodológica do artefato ou em termos de exposição das relações entre os elementos do artefato.

Nesta pesquisa, um método é proposto para analisar a influência dos fatores contextuais nas competências de liderança *lean*. O desenvolvimento do método possui uma base tanto teórica quanto empírica. A literatura serviu como base para a identificação das lacunas teóricas,

da natureza das competências de liderança e dos fatores contextuais, permitindo aos pesquisadores o desenvolvimento de um esboço do método. Quanto à base empírica, o método foi testado e refinado baseado na sua aplicação em uma planta de uma empresa de manufatura.

O método não está limitado a nenhum tipo específico de organização que busca a implementação do SPE. Considerando o método como um produto da DSR, ele deve ser interpretado como um projeto genérico utilizado como um “modelo feito por projetistas bem treinados e experientes a fim de realizarem seus próprios projetos em contextos específicos” (VAN AKEN et al., 2016). O projeto genérico deve ser suficientemente bem documentado a fim de permitir aos praticantes utilizá-lo como um modelo para projetos de casos específicos (VAN AKEN et al., 2016).

1.5. DELINEAMENTO DA PESQUISA

O trabalho foi dividido em 3 artigos conforme a estrutura de tese definida pelo regimento do Programa de Pós-Graduação em Engenharia de Produção da UFRGS (PPGEP/UFRGS). A estratégia de pesquisa e os procedimentos metodológicos são diferentes em cada artigo, mas eles convergem para a estratégia de pesquisa da tese apresentada na seção anterior.

O Artigo 1, intitulado “*Leadership in lean production systems: how it is related to general leadership theories*”, tem como principal objetivo o aprofundamento sobre o conhecimento sobre liderança *lean*. Para tal foi realizada uma revisão de literatura em três bases de dados tendo como pano de fundo três constructos base das teorias gerais de liderança: características do líder, processo de influência e contexto. Em paralelo à pesquisa sistemática, foi elaborada uma análise das teorias de liderança mais pesquisadas atualmente em relação aos constructos base que proporcionaram a identificação da contribuição das teorias de liderança para a expansão do conhecimento sobre a liderança *lean* na forma de proposições. Este artigo foi submetido e aprovado no periódico *Production Planning and Control* (Qualis A1)

O Artigo 2, intitulado “*Lean leadership competencies – a multi-method study*”, tem como principal objetivo identificar e validar as competências de liderança *lean*. A coleta de dados envolveu uma revisão de literatura das competências de liderança *lean*, entrevistas com

especialistas e uma *survey* respondida por 91 representantes de empresas de diferentes setores. Estas técnicas proporcionaram um conjunto de dados qualitativos e quantitativos o qual serviu como base para a identificação e validação de uma lista com dezesseis competências de liderança. Este artigo foi submetido e aprovado no periódico *Management Decision* (Qualis A2). Foi também apresentado na 28ª Conferência POMS em Seattle (EUA) onde recebeu a menção honrosa no prêmio EEDSA (*Emerging Economies Doctoral Students Award*).

O artigo 3, intitulado “*The influence of context on lean leadership competencies*” é resultante da última etapa desta tese e o principal objetivo desta etapa é responder à questão: “qual o impacto do contexto sobre as competências de liderança *lean*?” A fim de responder esta questão, um método, composto por sete passos, para a análise da influência do contexto sobre as competências de liderança foi desenvolvido e testado em uma planta industrial de uma empresa que vem desenvolvendo um SPE como política corporativa há mais de 5 anos. Este artigo foi submetido e aprovado no periódico *International Journal of Lean & Six Sigma* (Qualis A2).

De forma resumida, a contribuição de cada artigo para o atingimento dos objetivos da pesquisa é apresentada na Tabela 1.1. Para tanto, apresenta a principal questão de pesquisa respondida em cada artigo, o método escolhido para responder à questão e a relação com os objetivos da tese.

Cabe ressaltar que, na perspectiva da DSR, os artigos 1 e 2 são entendidos como parte da compreensão do problema, enquanto o artigo 3 apresenta o desenvolvimento do método, focado na resolução do problema (HOLMSTRÖM et al., 2009; MARCH e SMITH, 1995).

Tabela 1.1 - Contribuição dos artigos no alcance dos objetivos da pesquisa
Fonte: elaborado pelo autor

Artigo	Questões de Pesquisa	Método	Relação com os objetivos da tese		
			Geral	i	ii

1	Como as teorias gerais de liderança pode ajudar a expandir o conhecimento sobre a liderança <i>lean</i> ?	Revisão de Literatura	X	X	
2	Quais são as competências de liderança <i>lean</i> ?	<i>Survey</i>	X		X
3	Como pode ser avaliada a influência do contexto sobre as competências de liderança <i>lean</i> ? Qual pode ser a unidade de análise para explorar as interações entre o contexto e as competências de liderança <i>lean</i> ?	<i>Design Science Research (DSR)</i>	X	X	X

1.6. ESTRUTURA DA TESE

Esta tese é composta por um capítulo introdutório; três artigos, onde cada um representa o cumprimento de uma das etapas do delineamento da pesquisa; e um capítulo para as considerações finais, totalizando cinco capítulos.

Por último, o capítulo 5 apresenta as contribuições do estudo, retomando os objetivos do problema de pesquisa originário desta tese. Nesse capítulo também são apresentadas as limitações e direcionamentos de estudos futuros.

1.7. DELIMITAÇÕES DA TESE

A pesquisa possui as seguintes delimitações:

- i. A seleção das teorias de liderança está delimitada pelas que mais receberam atenção em termos de pesquisa, teoria e prática de acordo com Avolio et al. (2009) e Bass e Bass (2009) e, por aquelas teorias discutidas em artigos relacionados à liderança *lean*. Assim, não foram cobertas todas as teorias de liderança existentes). Isto se faz necessário dado que o campo de conhecimento sobre lideranças é muito amplo e envolve também outros domínios como psicologia e comportamento organizacional;

- ii. O trabalho está delimitado nas competências de lideranças em nível individual. Assim, o desenvolvimento de competências a nível da organização ou da equipe (DE VASCONCELOS et al., 2003; ESCRIG-TENA e BOU-LLUSAR, 2005) não serão aprofundadas no estudo embora possam ser referenciadas ao longo do trabalho;
- iii. O método proposto foi testado em um contexto específico e, portanto, generalizações sobre sua efetividade requerem novas aplicações. A respeito disto, um ponto a ser destacado é que as ferramentas específicas utilizadas no estudo de campo (por exemplo, os questionários e suas escalas) não devem ser vistas como elementos fundamentais do método. O que importa é a lógica do método, o qual pode ser compatível com outras ferramentas diferentes. Além disso, enquanto o método tenha sido testado em um cenário de manufatura, ele não é específico para este setor.

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2. LEADERSHIP IN LEAN PRODUCTION SYSTEMS: HOW IT IS RELATED TO GENERAL LEADERSHIP THEORIES

Abstract

Leadership has been cited by several studies as key for the success of lean production. However, studies on Lean leadership are not usually based on any leadership theory lens and the extent to which general leadership theories are relevant to Lean leadership has not yet been properly investigated. The research question addressed by this study is: “How can general leadership theories help to expand the knowledge about Lean leadership?” Seven general leadership theories were adopted as bases: Authentic Leadership, Leader-Member-Exchange, Complexity Leadership, Distributed Leadership, Transformational Leadership, Servant Leadership, and Situational Leadership. The research method involved: (i) a literature review of Lean leadership as to identify how it accounts for three core constructs of the general leadership theories, namely leaders’ personal attributes, influence process, and context; (ii) a comparison between Lean leadership with general leadership theories based on the same three constructs; and (iii) the development of propositions intended to guide future research and practice of Lean leadership. Results indicate that Lean leadership shares characteristics with all of the investigated general leadership theories and it can be interpreted as the instantiation of the said theories in a lean system. Based on this, a new definition of Lean leadership is also proposed.

Keywords: lean management, lean leadership, leadership theories

2.1. INTRODUCTION

Leadership plays a key role for the sustainable and integrated implementation of Lean Production (LP) practices, given the socio-technical nature of lean systems (Mann, 2009, Yadav et al. 2016, Shah and Ward, 2003). Indeed, leadership has been identified by several studies as one of the main factors for the success of Lean Production (LP) systems (Achanga et al., 2006; Alagaraja and Egan, 2013). In Found and Harvey’s (2007) research, 90% of the senior managers interviewed mentioned leadership as one of the three main factors for the success of LP implementation. The scientific literature about leadership in LP systems covers a broad range of topics, such as behaviours (Camuffo and Gerli, 2018; Van Dun et al., 2017), values (van Dun and Wilderon, 2016, van Dun et al., 2017), roles and responsibilities (Poksinska et al., 2013;

Marksberry, 2010), techniques for its development (Marksberry et al., 2010), and preferred leadership styles according to lean maturity (Tortorella and Fogliatto, 2017), hierarchical level (Tortorella et al., 2017; Marksberry and Hughes, 2011) and contextual variables (Tortorella et al., 2018; Gelei et al., 2015).

There are also many publications about Lean leadership (e.g. Mann, 2009; Emiliani, 1998; Liker and Convis, 2011; Spear, 2004) that have not been carried out as academic research and are mostly based on their authors' own experiences. Similarly, some studies do not present a verifiable research method to support their findings, despite pointing towards Lean leadership characteristics (e.g. Emiliani, 2003; Emiliani and Stec, 2005; Liker and Ballé, 2013). These drawbacks are not uncommon in the LP literature, which is strongly influenced by the practitioner-oriented literature (Farris et al., 2009).

Moreover, studies on Lean leadership in general are not usually based on any leadership theory lens, and the ones that use them tend to focus on Transformational Leadership (TL) (e.g. Found and Harvey, 2007; Steed, 2012) or Situational Leadership (SL) theory (e.g. Tortorella and Fogliatto, 2017). Therefore, the extent to which general leadership theories are relevant to Lean leadership has not yet been properly investigated, even though there are pieces of evidence indicating that the general literature is clearly relevant. For instance, LP has been more and more applied in highly complex socio-technical systems like healthcare (Soliman and Saurin, 2017), which may benefit from insights of Complexity Leadership theory (Uhl-Bien et al., 2007). Another example relates to the study of teamwork, which is key to LP (Marksberry et al., 2010), in the field of leadership theories (Dinh et al., 2014). Although it has significantly increased in the past few years, the existing research on Lean Leadership is still fragmented and poorly supported on widely deemed leadership theories (Tortorella et al., 2018; Van Dun et al., 2017).

As such, there is a risk of endowing leadership with causal power on the outcomes of lean systems, with little clarity on the nature of the constructs involved and the causation mechanisms. Existing definitions of Lean leadership are not explicitly based on theoretical background related to general leadership theories, and therefore they point to divergent aspects, without any clear rationale. For instance, Emiliani (2008) defines Lean leadership as “beliefs, behaviours, and competencies that demonstrate respect for people, motivate people, improve

business conditions, ensure effective utilization of resources, and eliminates confusion and rework”. In turn, Mann (2009) defines a Lean leader as someone who behaves according to eight attributes that encompass, for example, passion for lean, disciplined adherence to process, project management orientation, ownership, and effective relations with support groups.

Based on the aforementioned gaps, the research question addressed by this study is stated as follows: “How can general leadership theories help to expand the knowledge about Lean leadership?” As a first step for answering this question, a literature review of Lean leadership was carried out, in order to identify how it accounts for three core constructs of the general leadership theories (Yukl, 2010; McCauley, 2010), namely leaders’ personal attributes, influence process, and context. Next, these same three constructs were adopted as a basis for comparing Lean leadership with general leadership theories. Then, propositions intended to guide future research and practice of Lean leadership were developed, by linking lean leadership to each of the discussed general theories.

2.2. BACKGROUND

2.2.1. Lean leadership: how it has been approached by previous lean reviews

Although several literature reviews of LP have been carried out over the years, only a few were focused on Lean leadership. The review conducted by Van Dun et al. (2017) addressed lean leaders’ behaviours (e.g. listening and encouraging employees, and less engaged in monitoring task and providing negative feedbacks) and their underlying values, namely honesty, candor, participation, teamwork, and continuous improvement. In turn, Aij and Teunissen (2017) conducted a review considering the context of Lean leadership in healthcare in order to identify a list of attributes for lean leaders.

Apart from these two studies, the general lean literature reviews approach Lean leadership as a secondary theme. Sangwa and Sangwan (2017), for instance, performed a literature review of lean assessment, and highlighted the need for having a leader for this process. Also, on the topic of lean assessment, Narayanamurthy and Gurumurthy (2016) pointed out to the lack of lean assessment approaches that considered behavioural aspects, such as those associated with leaders.

Jasti and Kodali (2016) reviewed 35 lean implementation frameworks and top management leadership was identified as a pillar of most of them. Furthermore, lean literature reviews that recognise the social dimension of LP indirectly refer to Lean leadership, even though this term may not have been used in the study. For example, Yadav et al. (2017) discuss the process of organisational change involved in lean implementation, which may require an active role played by leaders. Hasle et al. (2012) reviewed the impacts of lean on working conditions and found strong evidence of negative impacts in cases of low complexity manual work; leadership presumably would be required to intervene in such situations.

2.2.2. Three constructs for analyzing lean leadership

Yukl (2010) and McCauley (2010) suggested that leadership can be analyzed according to three dimensions that are common to the general leadership theories. They are: (i) leaders' personal attributes, (ii) influence process and (iii) context.

“Personal attributes” is used in this paper as an umbrella term to refer to skills and personality traits. A skill is a goal-oriented, well-organised behavioural or cognitive capability that is acquired through practice and performed with economy of effort (Proctor and Dutta, 1995). In turn, personality traits are enduring, predictable characteristics of individual behaviour that explain differences in individual actions in similar situations (Llewellyn and Wilson, 2003). Thus, while human personality remains relatively constant over one's lifespan, skill acquisition is far more manageable through training (McCrae et al., 2002).

Second, most leadership theories acknowledge leadership as an influence process between the individual that exerts the influence (leader) and the one influenced, or follower (McCauley, 2010). The influence process occurs primarily through the behaviours of the leaders (Derue et al., 2011), which are an observable activity of the individual that can be objectively described (Bruvold, 1972). Additionally, leaders may also use some tools and tactics in order to exert their influence (Yukl, 2010; Bass and Bass, 2009).

Third, context refers to independent variables that may affect outcomes or modify how individuals are related to outcomes (Diez-Roux, 1998). Contextual variables generally

represent situational characteristics that are either exogenous to the focal organisation or to the leader under study (Amores et al., 2005). The opportunity to control or manipulate these variables is, at best, limited or indirect; even if the organisation or leader might be able to change such variables, this is only possible in the long run and by investing significant amounts of effort (Anand and Kodali, 2008). Thus, context comprises the environment, organisation, technology and structure operating within a system where leadership operates (Osborn et al., 2002).

This study adopts leaders' personal attributes, the influence process between leaders and followers, and context as the key constructs for comparing Lean leadership to leadership theories. These dimensions have a correspondence with the proposal by Blickle et al. (2013), who explain leaders' characteristics as "who leaders are", leaders' behaviours as "what leaders do", and the context where leaders are embedded in as "what their situation is like".

2.3. RESEARCH METHOD

The research strategy to answer the research question was a literature review of lean leadership. The steps adopted in the literature review itself were those proposed by Kitchenham (2004) and Staples and Niazi (2007), namely planning the review, conducting the review, and data analysis. These steps are described from Sections 3.1 to 3.3.

2.3.1. Planning the review

According to Staples and Niazi (2007), the output of this step is a protocol that sets the review purpose and procedures. Three widely deemed scientific databases were included in the search for papers: *EBSCO Business Source Complete*, *EBSCO Academic Search Complete*, and *Web of Science*. The searches took place on May 2018 and were updated on Nov 2018. The following criteria were used to search relevant articles:

- i. Terms "Lean*" AND "Leadership" in the title, abstract and/or keywords. The term "Lean" was used with "*" to broaden the search with similar uses of the term Lean as "production", "manufacturing", "systems", "management", or "thinking";

- ii. Full text available in English;
- iii. Only journal papers were analyzed, and thus non-scientific papers, conference proceedings, and book chapters were not included in the search criteria; and
- iv. Period of publication was not specified.

In addition to this, other papers not captured by the search in the said databases were added by the authors. These papers were identified from the references cited by the papers from the databases. This procedure was adopted in other reviews of lean systems (e.g. Albjørn and Freytag, 2013; Petersen, 2009)

2.3.2. Conducting the review

This step, according to Staples and Niazi (2007), generates the initial search record, the list of selected publications and extracts data for each selected publication. The three database searches returned 470 results which have received the addition of 5 more studies that were not captured by the databases searches, resulting in 475 studies in total.

All papers had their titles and abstracts read, which excluded 369 results due to their lack of adherence to the research theme. As a result, 106 papers remained. Next, duplicates were excluded, and, at the end of this step, 74 papers remained. These papers were fully read as to ensure that their content was relevant to this study, and at least one of the three data analysis dimensions were discussed – i.e. leaders’ personal attributes, influence process, and context. This analysis eventually resulted in 47 selected studies (Table 2.1).

Table 2.1- Filtering process to determine the final portfolio of articles

Data base	Keywords	Initial result	Criteria for analysis			
			Title and abstract alignment	Duplicates	Full text alignment	
EBSCO Business Source Complete	"Lean" & "Leadership"	136	-369	-32	-27	

EBSCO				
Academic	106			
Search Complete				
Web of Science	228			
Additional papers	5			
Total of studies considered in the study	475	106	74	47

2.3.3. Data analysis

The main data analysis procedure was a direct content analysis (Hsieh and Shannon, 2005), which starts with the identification of key concepts as initial coding categories – i.e. in this study, the three core leadership constructs. The second step was to highlight all the excerpts of text associated with the predetermined codes. Data coding was performed by the first author and, in order to improve the reliability, the results were thoroughly reviewed by the remaining authors. Disagreements between them were discussed until a consensus was achieved.

Then, the characterization of the lean leadership literature according to the three leadership constructs was checked against the assumptions of a set of general leadership theories about the same said constructs. Two criteria for selecting the general theories were adopted, as follows: (i) those receiving more attention in terms of research, theory, and practice, according to Avolio et al. (2009), and Bass and Bass (2009), and (ii) those theories discussed in the papers that address lean leadership. Based on this, seven theories were selected: Authentic Leadership, Leader-Member-Exchange, Complexity Leadership, Distributed Leadership, Transformational Leadership, Servant Leadership and Situational Leadership. Data analysis was concluded with the elaboration of propositions that convey expected relationships between Lean leadership and the general theories, which should be empirically investigated in future studies.

2.4. RESULTS

2.4.1. Overview of the selected studies

In 38% of the selected studies, leadership was not the main subject, being approached either as a critical success factor of LP (Booker et al., 2016; Kumar et al., 2014), or as a

necessary, but non-existent factor for supporting changing efforts towards Lean (Arif, 2016; Donnelly, 2015). A gap was observed regarding the lack of studies that connect Lean leadership with leadership theories. Only 13 out of the 47 studies discuss some of the leadership theories (27%), prevailing the Transformational Leadership (21% of the total), Situational Leadership (4% of the total), and Servant Leadership theories (2% of the total).

Concerning the three leadership constructs, personal attributes were present in 41 studies (87% of the total), influence process in 25 studies (53%), and contextual factors in 27 (57%). Some studies accounted for two or three leadership constructs, respectively 19 (40%) and 13 studies (28%). These results highlight the need for this study, which takes into account the three constructs altogether.

2.4.1.1. *Lean leaders' personal attributes*

The review of the Lean leadership literature indicated 21 personal attributes (Table 2.2) divided in personality traits (38%) and skills (62%). All of these attributes are relevant from the perspective of Lean principles. For instance, the trait “value follower” is key, since LP is primarily a management philosophy (Bhasin and Burcher, 2006) which is associated with a specific thinking process (Hines et al., 2004) that must be practiced by the leaders on a daily basis (Liker and Convis, 2011). Similarly, the skill “coaching/mentoring” is essential for operationalising some Lean principles proposed by Liker (2004) like “develop exceptional people and teams that follow their company's philosophy”.

Table 2.2 – Lean leaders' personal attributes

Personal attributes	Studies																																									Total			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41				
Personality traits																																													
Modesty & Humility							X																											X	X	X			X	X	X	X			
Commitment																																		X			X	X			X	X	X	X	
Discipline											X																		X												X	X	X	X	
Value follower																									X											X					X	X	X		
Self development													X																						X						X	X			
Credibility																																		X				X			X	X			
Empathy	X														X																											X			
Transparency															X														X													X			
Skills																																													
Support the changes				X	X	X		X		X	X			X	X	X	X							X	X	X		X					X	X	X						X	X	X		
Communication							X	X							X	X		X	X	X					X	X							X		X	X	X			X	X	X	X		
Challenge & Motivation	X		X				X	X					X							X							X					X		X	X	X			X	X	X				
Coaching & Mentoring			X				X				X													X	X	X		X	X			X	X	X							X	X			
Persuasion	X	X			X		X			X					X					X				X				X					X								X	X			
Problem solving							X			X	X	X										X	X					X				X		X	X							X	X		
Critical thinking													X											X				X						X				X			X	X			
People development		X					X																				X						X				X				X	X			
Empowerment					X			X																				X						X		X						X			
Control											X													X													X	X		X			X		
Situational analysis																																		X	X	X			X			X			
Long-term vision																																					X		X	X					
Risk management																														X															

Notes: (1) Arif (2016); (2) van Rossum et al. (2016); (3) Booker et al. (2016); (4) Goodridge et al. (2015); (5) Kane et al. (2015); (6) Gelei et al. (2015); (7) Aij et al. (2015a); (8) Aij et al. (2015b); (9) Boak et al. (2015); (10) Lantz et al. (2015); (11) Donnelly (2014); (12) Poksinska et al. (2013); (13) Aij et al. (2013); (14) Emiliani and Emiliani (2013); (15) Anand et al. (2012); (16) Psychogios and Tsironis (2012); (17) Papadopoulos et al. (2011); (18) Dahlgaard et al. (2011); (19) Sankowska and Rygowska-Ziellinska (2015); (20) Found and Harvey (2007); (21) Lorden et al. (2014); (22) Miller and Maellaro (2016); (23) Wyton and Payne (2014); (24) Roth (2006); (25) Sarkar (2011); (26) Mann (2009); (27) Stewart and Adams (1998); (28) Seppala (2004); (29) van Dun et al., 2017; (30) Tortorella and Fogliatto (2017); (31) Camuffo and Gerli (2018); (32) Fine et al. (2009); (33) Aij and Rapsaniotis (2017); (34) Aij and Teunissen (2017); (35) Dibia et al. (2014); (36) Laureani and Antony (2016); (37) Ljungblom (2012); (38) Steed (2012); (39) Emiliani (1998); (40) Spear (2004); (41) Marksberry (2010).

According to Table 2.2, the attribute “support the changes” was the most frequently cited (20 studies, or 49%). Indeed, LP systems typically involve a number of organisational, social and often technical changes, which may trigger resistance from employees of different hierarchical levels (Marodin and Saurin, 2015).

Other attributes are also clearly related to the social interactions in Lean systems (Shah and Ward, 2003). Examples of these attributes are “communication” (41%), “challenge/motivation” (37%), “coaching/mentoring” (32%), and “persuasion” (29%). These attributes can be used as a basis for recruiting and selecting new workers and leaders, which may support the development of leaders aligned with the Lean philosophy (Liker and Convis, 2011).

2.4.1.2. Lean leadership influence process

Similarly to leaders’ personal attributes, leaders’ influence process through behaviours must be aligned with LP principles. For instance, De Jong and Den Hartog (2007) described how leaders influenced employees’ innovative behaviour and found that it occurred by their deliberate stimulation of idea generation. Some papers provide explicit descriptions of how Lean leaders influence followers based on their behaviours (Table 2.3). For example, Kane et al. (2015) describe a daily routine where visual boards are used as tools to engage employees in the improvement process. Aij et al (2015a) discuss the importance of the practice of going to see the situation with one’s own eyes to better understand the problem. The same authors also discuss the importance of a formal management system in order to moderate leaders’ and followers’ behaviours. Mann (2009) also describes the management system as a core element in LP implementation, which enables the influence process of leaders.

In fact, the importance and description of the management system associated with LP is not new. Monden (1998) describes the management system in detail, although he placed little emphasis on the social aspects of the system, which was not explicitly indicated.

Table 2.3 – Lean leadership influence process

Behaviours	Studies																									Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Supporting the changes (kaizen activities)	X	X				X	X	X	X	X					X		X		X	X			X	X	X	14
Supporting problem solving					X					X	X	X			X			X	X			X	X	X	X	11
Sharing value added information				X		X			X	X	X						X					X		X	X	9
Challenging followers	X					X			X							X	X			X	X		X	X		9
Coaching people						X	X								X		X	X				X	X	X		8
Empowering followers			X														X	X	X			X	X	X	X	8
Behaving according to the management system			X										X	X		X					X			X	X	7
Teaching lean principles						X	X													X			X	X	X	6
Providing constructive feedback						X	X												X	X				X	X	6
Performing gemba walks with visual boards					X	X				X					X		X									5
Supporting daily routine using visual boards		X						X		X					X											4
Going to the gemba to see the situation for one's self			X							X														X	X	4
Rewarding success	X																X	X		X						4
Performing monthly meetings to discuss the advance				X																X						2

Notes: (1) Booker et al. (2016); (2) Kane et al. (2015); (3) Aij et al. (2015a); (4) Boak et al. (2015); (5) Donnelly (2014); (6) Poksinska et al. (2013); (7) Emiliani and Emiliani (2013); (8) Papadopoulos et al. (2011); (9) Zacharatos et al. (2007); (10) Meyer (2010); (11) Lorden et al. (2014); (12) Miller and Maellaro (2016); (13) Roth (2006); (14) Mann (2009); (15) Tortorella and Fogliatto (2017); (16) Camuffo and Gerli, 2018; (17) Fine et al. (2009); (18) Aij and Rapsaniotis (2017); (19) Aij and Teunissen (2017); (20) Dibia et al. (2014); (21) Ljungblom (2012); (22) Steed (2012); (23) Emiliani (2003); (24) Spear (2004); (25) Marksberry (2010).

All behaviours identified in Table 2.3 are a key for LP, such as coaching and performing audits in the shop floor (i.e. *gemba* walks, in Lean jargon). This manifests through a questioning process named Kata of Coaching (Rother, 2009) where leaders promote the development of their team by inquiring them. Performing *gemba* walks is a practice by which the leaders go to the shop floor to see what is actually happening (Mann, 2009; Spear 2004). Gemba walks are crucial to maintain the adherence to the Lean initiatives and it is made up of three activities: going to the place, looking at the process, and talking to the people (Mann, 2009).

Making problems visual underlies several behaviours mentioned in Table 2.3 (e.g. performing *gemba* walks and supporting daily routine), and it consists of influencing followers through the use of visual management strategies that demand quick responses by the team involved in the process (Parry and Turner, 2006). Another important influencing tool for lean leaders is the daily accountability. It refers to a daily meeting structure with the purpose of following up tasks assigned to solve problems or developing improvements (Poksinska et al., 2013). Elnadi and Shehab (2015) identify it as an enabler for a successful LP implementation, as it works in order to communicate the status and solving problems on a daily basis.

It is worth noting that the effectiveness of some of the influence processes depends on the existence of the correspondent personal attributes. For instance, influence through “supporting daily routine using visual boards” implies a leader who is well versed in communication and critical thinking skills and possesses the trait of discipline. This and other influence processes can be interpreted as the operationalization of the personal attributes in practice.

2.4.1.3. *Lean leadership context*

The literature review pointed out 10 contextual factors that impact on Lean leadership (Table 2.4). All of these factors also impact on other dimensions of lean, as identified by previous studies (Marodin and Saurin, 2015; Netland, 2016; Tortorella et al., 2018).

Some of these factors are external to the organisation. For example, the factor “nature of the business” implies in certain characteristics of the organisational culture that tend to be similar across different organisations pertaining to a same sector. Healthcare illustrates this point, to the extent that there is a large power imbalance between doctors and the other professional categories (Xyrichis and Ream, 2008). This poses difficulties for teamwork and consensus building, which are desirable in lean systems.

Table 2.4 – Contextual factors that influence lean leadership

Contextual factor	Why is it relevant to leadership?	Studies																											Total	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27		
Management system	The management system defines the standardised planning and control routines that support the daily work of lean leaders				X		X			X	X	X					X	X									X	X	X	10
Nature of the business	The nature of the business may encompass certain social and technological characteristics that either reduce or amplify the degrees of freedom of lean leaders	X			X			X			X									X	X	X	X				X		9	
Customer requirements and level of competitiveness	Lean leaders may need to prioritize some behaviours in detriment of others due to customer requirements and level of competitiveness									X	X				X				X		X	X				X		X		8
Education and training of the workforce	Social interactions and approaches for coaching need to be adjusted according to the level of workforce education and training								X						X				X	X							X		5	
Country culture	Country culture influences on the nature of the social interactions and values, and therefore on the relationship between lean leaders and their followers		X						X					X							X									4
Sectorial policies and standards	Sectorial policies and standards, such as those defined by automakers, set constraints and priorities for the daily work of lean leaders				X			X			X																			3
Organisational complexity	Organisational complexity implies a large number of diverse elements in dynamic interactions. This makes it difficult the anticipation of the impacts of the decisions made by lean leaders					X						X								X										3

Approach of lean implementation	Different approaches for lean implementation may place different emphasis on the role played by lean leaders - e.g. highly standardised lean systems in large multinational companies may underuse the creativity of lean leaders				X	X	X	3
Social, legal, and political external environment	The external environment poses constraints and opportunities that influence the daily work of lean leaders (e.g. legislation that facilitates the large-scale use of temporary work contracts may discourage solid social relationships between leaders and followers)	X			X		X	3
Organisation size	Larger organisations can require more hierarchical levels and create communication barriers between leaders and followers						X	1

Notes: (1) Arif (2016); (2) Li et al. (2015); (3) Goodridge et al. (2015); (4) Kane et al. (2015); (5) Aij et al. (2015a); (6) Aij et al. (2015b); (7) Boak et al. (2015); (8) Kumar et al. (2014); (9) Poksinska et al. (2013); (10) Aij et al. (2013); (11) Anand et al. (2012); (12) Papadopoulos et al. (2011); (13) Sankowska and Rygowska-Ziellinska (2015); (14) Meyer (2010); (15) Wyton and Payne (2014); (16) Roth (2006); (17) Mann (2009); (18) Seppala (2004); (19) Tortorella et al. (2018); (20) Fine et al. (2009); (21) Aij and Rapsaniotis (2017); (22) Aij and Teunissen (2017); (23) Laureani and Antony (2016); (24) Steed (2012); (25) Emiliani and Stec (2005); (26) Spear (2004); (27) Marksberry (2010).

The “country culture” is another example of external factor. This affects the level of individualism of a society, which in turn underlies workers’ reasons for complying (or not) with organisational requirements, as well as plays a role in the hiring of employees for positions of special influence (Pagell et al., 2005).

In turn, several other contextual factors are internal to the organisation, but exogenous to the leader. These factors are related to the way the work is structured, such as the maturity of the LP system (Narayanamurthy and Gurumurthy, 2016), and the complexity of the organisation (Sangwa and Sangwan, 2018; Yadav et al, 2017). Regarding complexity, its functional manifestation occurs mostly through the functional areas of the organisation that are related to lean (e.g. human resource, finance, supply chain, product development, and customer management) (Sangwa and Sangwan, 2018). Behaviours and decisions of lean leaders influence and are influenced by the said functional areas.

Complexity is also important to the extent that it guides leaders’ decision-making regarding whether or not to use lean practices in a certain context. This is discussed by Goodridge et al (2015) when designing pull systems in a hospital. These authors reported the use of the *kanban* type of pull systems as an effective means of managing supplies in highly structured laboratory settings, instead of in the typically chaotic environment of an emergency department.

2.4.2. Contributions from leadership theories

In this Section, the central aspects of the selected general leadership theories are described as well as their relevance from the lean viewpoint. Based on this, propositions to guide further research and practice are presented.

Authentic Leadership theory

Authentic Leadership theory states that followers' work engagement arises from their empowerment and identification with the leader, who should show consistency in their words, actions, and values (Yukl, 2010; Uhl-Bien, 2006). This approach is relevant to Lean, in particular at the influence process dimension, since lean involves changes in work practices that demand persistence and practical demonstration of know-how of the leader. In turn, the personal attributes commonly associated with authentic leaders are: value follower, responsibility, awareness, discipline, self-awareness, transparency and engagement (Gardner et al., 2011; Yukl, 2010; Avolio et al., 2009). Organisational context also influences the development of authenticity in leaders, by providing means to support self-awareness and self-regulated positive behaviours on the part of leaders and followers (Yukl, 2010; Uhl-Bien, 2006). The proposition associated with this theory is stated as follows:

Proposition 1: *Authentic Leadership theory can be used to better understand how Lean leadership behaviours influence the engagement of the employees as well as the characteristics of the organisational context that support it.*

Leader-Member Exchange theory

The Leader-Member Exchange Theory describes the role-making process between a leader and the led as well as their exchange relationship over time (Yukl, 2010). The quality of relationships is affected by the context in which these relationships have been developed (Avolio et al., 2009). For instance, Kacmar et al. (2007) indicate that supervisor competence, and centralised decision making moderate the relationship between leader and follower.

The lean behaviours identified in Table 2.3 (see Section 4.1.2) can be interpreted from the point of view of the relationships between leader and follower. For example, the outcome of a kaizen is influenced by the leader's behaviour "supporting kaizen activities" and it is also dependent on the quality of the relationships between leader and their team involved in the activity. A relationship with high level of trust may result in better performance (Graen et al., 1982). This theory can be relevant to the study of Lean leadership as it sheds light on how leaders can support continuous improvement through high-exchange relationships within their teams. Thus, for the Leader-Member Exchange theory, we developed the following proposition:

Proposition 2: *Leader-Member Exchange theory can be used to better understand how lean leaders can develop high-exchange relationship with their teams.*

Complexity Leadership theory

Complexity Leadership theory states that leadership only exists in, and it is a function of, interaction (Uhl-Bien et al., 2007). The dynamic relationships occur between the formal top-down, administrative forces and the informal, complex adaptive emergent forces of social systems (Uhl-Bien et al., 2007). This theory values both formal and informal influence mechanisms. Thus, it is aligned with Lean, which places an emphasis on the presence of leaders at the *Gemba* (see behaviours listed in Table 2.3). This presence offers plenty of opportunities for exerting influence through informal means, while not excluding formal opportunities, like meetings and training.

Regarding context, for Complexity Leadership theory, leadership is embedded in a complex interaction of numerous contextual factors (Avolio et al., 2009), which allow for the opportunistic use of influence mechanisms of specific leaders. Thus, it is important to lean due to the several contextual factors that may play a role in a lean system (see Table 2.4). As such, we developed the following proposition:

Proposition 3: *Complexity Leadership theory can be used to better understand how contextual factors, that could be related to the organisation, personal, technical or any other contingent aspect, influence on lean leaders' personal attributes as well as on the relationship between lean leaders and followers.*

Distributed Leadership

Distributed Leadership is characterised by Avolio et al. (2009) as a dynamic influence process among individuals in groups for which the objective is to lead one another to the achievement of group or organisational goals. It involves multiple leaders with distinct but inter-related responsibilities, and both formal and informal leaders may be involved (Yukl, 2010). In Distributed Leadership, the influence process often involves peer influence and at other times involves upward or downward hierarchical influence (Avolio et al., 2009). The

emphasis on bi-directional influence (leaders-followers-leaders) is relevant to Lean, since leaders are also supposed to receive feedback from followers and they also should improve their performance continuously. In addition, the emphasis on peer influence (within the team) is aligned with Lean since it is strongly based on teamwork (Marksberry, 2010).

In terms of context, Distributed Leadership considers that relationships are continually being modified as changes occur in the people who are involved in the collective activity, and as changing conditions trigger adaptive responses (Yukl, 2010; Uhl-Bien, 2006). For instance, Marodin and Saurin (2015) found empirical evidences of the network of interactions from contextual, social and technical variables on a number of barriers for Lean implementation. Thus, we developed the following proposition:

Proposition 4: *Distributed Leadership theory can be used to better understand how Lean leadership occurs as a process by mutually influencing leaders and followers, embedded in a network of interactions with the organisational context.*

Transformational Leadership

In Transformational Leadership, leaders have four primary approaches for influencing followers, namely: (i) charismatic influence, (ii) inspirational motivation, (iii) intellectual stimulation, and (iv) individualised consideration (Stone et al., 2004). These approaches find resonance in lean leaders' behaviours (see Table 2.2). For instance, intellectual stimulation can arise from coaching, providing constructive feedback, and challenging followers, which is described in several reports of the Toyota Production System (e.g. Spear, 2004).

Transformational Leadership theory also indicates some leaders' behaviours by which followers are influenced, such as: articulating a clear and appealing vision, explaining how the vision can be attained, acting confidently and optimistically, expressing confidence in followers, and leading by example (Stone et al., 2004). The way leaders influence followers (e.g. intellectual stimulation, confidence in followers, etc.) proposed by this theory tend to be useful for Lean because followers need to be convinced of the need for the changes required by it and understand their role in this process (Bhasin and Burcher, 2006).

The personal attributes that Transformational Leadership emphasise are communication, empowerment, teaching, motivation and persuasion (Stone et al., 2004). All of those personal attributes are linked to the implementation of Lean (see Table 2.2). For example, continuous improvement in Lean systems is supported by teaching workers how to identify and solve problems, empowering them to implement their ideas, and delegating responsibility to achieve a higher performance level (Liker, 2004). Thus, the proposition as follows was developed:

Proposition 5: *Transformational Leadership theory can be used to better understand how Lean leadership influences followers to support continuous improvement activities, in a consistent manner with the organisational goals.*

Servant Leadership

According to Horner (1997) the focus of servant leadership is on others rather than upon self and on the understanding of the role played by the leader as a servant. For Yukl (2010), a servant leader must attend to the needs of followers and help them become healthier, wiser, and more willing to accept their responsibilities. Thus, in Servant Leadership, leaders trust their followers to undertake actions that are in the best interest of the organisation (Stone et al., 2004). This theory stresses that influence is exerted through the leaders' role of attending to the followers' needs. This is a key for Lean, which recognises that the main value-adding activity is made at the front-line (Womack and Jones, 2003). Thus, leaders must provide resources so as to facilitate the work of those who really add-value to the end client.

The personal attributes that Servant Leadership emphasise are integrity, modesty, empathy, fairness, engagement, relationship development, empowerment, listening and persuasion (Stone et al., 2004). Some of those personal attributes have already appeared on the Lean implementation literature. For example, empathy was considered to be an important personal trait for Lean leadership by Anand et al. (2012), and persuasion and communication were among the most mentioned leadership skills on the Lean literature (see Table 2.2). The proposition associated with servant leadership theory is as follows:

Proposition 6: *Servant Leadership theory can be used to better understand how lean leaders can more effectively account for the workers' needs and perspectives, especially their viewpoint about the changes introduced by continuous improvement activities.*

Situational leadership

Situational leadership theory postulates the existence of four leadership styles, ranging from directing to delegating, and a framework for matching each style to specific situations (Thompson and Glasø, 2013). The fundamental principle of the situational leadership model is that there is no single "best" style of leadership. According to Hersey and Blanchard (1969), depending on the maturity of the subordinates, a leader should be task oriented or relations oriented. In situational leadership, the style may change continually to meet the needs of others in the organisation based on the situation. Thus, it is fundamental that leaders be capable of making sense of the situation (see Appendix A) in order to identify the best style to that specific context. Based on this, the proposition associated with situational leadership is as follows:

Proposition 7: *Situational Leadership theory can be used to better understand how Lean leadership should manifest under different contexts, such as maturity level of the lean system, complexity of the problems, and profile of the followers.*

2.5. DISCUSSION

2.5.1. Summarising the connection between lean leadership and the general theories

The results presented in the previous Section indicated the usefulness of three adopted constructs (leaders' personal attributes, influence process, and context) as a framework for the understanding of Lean leadership and for comparing it with the general leadership theories. In this Section the main points from this comparison are highlighted, initially more broadly considering the general theories altogether and then more specifically from the perspective of each of the general theories. As for the personal attributes, the similarity level between the attributes of Lean leaders (Table 2.2) and those identified in leadership theories (Appendix A) was estimated as per the ratio below:

$$\text{Similarity level (\%)} = \frac{\text{(number of attributes mentioned by the Lean leadership literature and that are also mentioned by the general leadership theories)}}{\text{(total number of attributes mentioned by the general leadership theories)}}$$

Therefore, the similarity was estimated in 54% (14 out of 26 attributes), which suggests that effective leaders who work in non-Lean environments may adapt to positively support a lean implementation. Four Lean leadership attributes that are listed in Table 2.2 are not mentioned by the leadership theories (see Appendix A): self-development, problem solving, support the changes, and risk management. This can be due to the fact that general leadership theories do not bear the managerial emphasis that Lean does, which is based on continuous improvement (demanding leaders' self-development skill) and changes in managerial paradigms (demanding problem solving, risk management and support the changes skills).

In spite of these differences and similarities, the ways of supporting and taking advantage of the attributes seem to be distinctive when developing lean leaders. For example, personal attributes of lean leaders, such as discipline, communication, and persuasion, are useful for the adoption of standardised problem-solving approaches (e.g. the A3 process), which require consensus building and negotiation with all affected parties before devising a final action plan. Furthermore, as a gap in literature, neither studies in leadership theories nor in Lean leadership discussed undesirable traits (e.g. narcissism and Machiavellianism) and their negative effects, as proposed by Judge et al. (2009).

As for the influence process, the discussed general theories describe it as a result of the leaders' behaviours and the social interactions between leaders and followers. However, as the description of the influence process by the general theories does not pay heed to specific influence mechanisms, a quantitative similarity analysis with the Lean leadership literature was not possible – the same reasoning applies to context. Nevertheless, some connections may be highlighted: (i) the leader must develop a positive relationship (e.g. trust, respect, and empathy) with the follower to whom the influence is exerted; (ii) the visible and observable leaders' behaviours are a fundamental component of the influence process; and (iii) the influence process needs to be compatible with both the internal and external context of the organisation; thus, not all influence processes promoted by lean are expected to be effective in all contexts.

These points have not been explicitly acknowledged by the Lean leadership literature and could play a role in explaining the difficulties of implementing and sustaining lean initiatives.

Regarding context, the recognition of its importance as both a source of constraints and opportunities for leadership is in line with the similar recognition that lean implementation is also context-dependent (Shah and Ward, 2003). However, the question of how to carry out a contextual assessment, and how to logically link this with the required leadership approach, has not yet been explored both in the general and in the Lean leadership literature. Table 2.5 summarises the main contributions of the general leadership theories to the understanding of Lean leadership.

Table 2.5 – Main contributions of the general leadership theories to Lean leadership

Leadership Theory	Main contributions for lean leadership	Constructs		
		Personal attributes	Influence process	Context
Authentic Leadership	(i) The understanding of how followers' work engagement arises from their empowerment and identification with the leader; (ii) the personal attributes by which the consistency in the leaders' words, actions, and values are exercised; (iii) the identification of organisational context that influences the development of authenticity in leaders.	X	X	X
Leader-Member-Exchange	(i) The description of the exchange relationship between a leader and their followers over time; (ii) the identification of contextual factors that influence the relationships		X	X
Complexity Leadership	(i) Understanding of the influence of the dynamic interaction among the several contextual factors with leadership; (ii) understanding how leaders exert influence in a dynamic context.		X	X
Distributed Leadership	(i) Understanding how the dynamic influence process occurs between the individuals in groups; (ii) understanding how context influences the relationships		X	X

Transformational Leadership	(i) Understanding how the influence of followers occurs by articulating a clear and appealing vision, explaining how the vision can be attained, acting confidently and optimistically, expressing confidence in followers, and leading by example, (ii) understanding how the personal attributes moderate the influence process between leaders and followers	X	X
Servant Leadership	(i) Understanding how the leaders attend to the needs of followers and help them become healthier, wiser, and more willing to accept their responsibilities		X
Situational Leadership	(i) Understanding how to analyze the context in order to identify the best style to deal with it; (ii) identification of which personal attributes are necessary in order to perform a situational analysis.	X	X

2.5.2. Defining Lean leadership

At this point, considering all analyses performed in this study and the definitions available in the literature, a definition of Lean leadership can be proposed:

Lean leadership is a dynamic social process, carried out by leaders with personal attributes aligned with Lean principles in order to sustain continuous improvement. These leaders are supported by a Lean management system compatible with the internal and external context of the firm.

Two aspects of this definition can be highlighted: (i) it is applicable to leaders across hierarchical levels and different types of organisations; and (ii) it considers leadership as a process that connects the three adopted constructs, making it clear that Lean leadership requires continuous adjustment to a dynamic context. The need for the *continuous adjustment to context* (e.g. different personalities of followers, and an increase of production pressures that may stress inter-personal relationships) must be emphasised since this involves the interactions that give rise to the emergent nature of Lean leadership. This emergent nature has also implications for the assessment of Lean leadership. As such, the three core dimensions are the ones that can and

should be directly assessed, and in this sense, they can be interpreted as the “potentials” for Lean leadership.

2.6. CONCLUSIONS

2.6.1. Contributions of this study

The research question addressed by this study was stated as follows: “How can general leadership theories help to expand the knowledge about Lean leadership?” In order to answer this question, an analysis was made of how seven general leadership theories offered insight into lean leadership, across three constructs that are common to Lean leadership and the general leadership theories.

All of the general theories were found to be relevant for Lean leadership, thus indicating that the approach of earlier studies was incomplete by focusing only on three (i.e. Transformational, Situational, and Servant Leadership theories) of the theories discussed in this paper. This mixed theoretical foundation suggests that Lean leadership may take on slightly different manifestations, with different emphasis, depending on the context in which it is exerted. For instance, manufacturing companies moving from a traditional mass production system to Lean may experiment greater resistance and fear from employees. In such an environment, an authentic and transformational leadership style may take priority over a servant leadership one. In turn, in a mature Lean system, a distributed leadership style may emerge as a natural by-product of followers who are aware of the importance and ways of using Lean principles. Based on these findings, it seems that Lean leadership may be interpreted as the practical instantiation of the other theories in a Lean environment, rather than a completely new leadership style.

The general leadership theories also supported the identification of gaps in the Lean leadership literature. For instance, this literature does not discuss the leaders’ personal attributes in depth. By contrast, the general leadership literature pays heed to these attributes (Zaccaro, 2007) and provides empirical evidence linking these to leadership effectiveness (De Rue et al., 2011). Thus, it is necessary to define, based on both theoretically and empirically grounded evidence, what characteristics best define a lean leader and how to assess them. Regarding the influence process, the general theories indicate that there are general approaches that have not

yet been explored by the lean literature, such as the mutual influence between followers and leaders as well as the development of mutual trust and high exchange relationships – mechanisms for the operationalization of these approaches in lean systems need to be investigated. As for context, the general theories suggest the need for the exploration of the causation mechanisms linking contextual factors to Lean leadership, as well as for the identification of desirable and undesired contexts.

Lastly, our findings indicated the key role played by the management system as an enabler of Lean leadership. The implementation and sustaining of LP can be associated with the development of a robust management system, which supports leaders to perform their roles. By contrast, current leadership theories do not assume the existence of any specific work system design, which at the same time makes them more generalizable but more difficult to be realised in practice.

2.6.2. Managerial implications

This study has some managerial implications that should be emphasised. First, the three constructs for analyzing Lean leadership may be a practical framework for practitioners interested in developing Lean leadership. The early identification of how these three constructs manifest in practice allows for proactive and theoretically grounded managerial actions, such as training programmes and work system re-design to cope with contextual changes. Second, the identified lists of personal attributes, influence mechanisms, and contextual factors set a basis for managers assessing how their own lean systems support Lean leadership. The contents of these lists may also inform the redesign of lean systems.

2.6.3. Limitations

There are some limitations of this study that should be mentioned, such as: (i) the use of different keywords would generate different results in the on-line literature search, (ii) the selection of leadership theories did not cover all the existing theories (e.g. ethical leadership was not included in this study); and (iii) the literature about leadership involves different domains like psychology and organisational behaviour, which were not considered.

2.6.4. Future studies

Considering that the topic of Lean leadership is relatively new from a scientific viewpoint, as well as its relationship with multiple general leadership theories, a number of opportunities for further research can be mentioned, as follows:

- i. To investigate the propositions suggested by our study (section 4.2), both theoretically and empirically. Future research should take a broader view of the theoretical foundations of Lean leadership by exploring the relative importance of the different theories as mentioned in the propositions. For example, considering proposition 4 (Distributed Leadership theory) a research question that can be addressed is: “what are the contextual factors that affect the process of mutual influence between leaders and followers?”
- ii. To develop tools for assessing the level of development of lean leaders. A research question corresponding to this opportunity is “how can the development of leaders in a lean system be assessed based on the Lean leadership definition proposed in this study?”
- iii. To investigate how the management system affects the leaders’ personal attributes, the influence process, and other contextual factors. A possible corresponding research question to be addressed is: “how should the influence process be supported by the management system in different maturity stages of lean systems?”
- iv. As mentioned in this paper, leaders’ personal attributes and the influence process are expected to be more stable in comparison with a potentially more dynamic internal and external context. Thus, a possible research question that could be addressed is “how does the context dynamics affect personal attributes and influence processes?”
- v. Leadership theories can also benefit from Lean leadership. In fact, there are leadership theories with a substantial background of theoretical research but a lack of empirical studies (Yukl, 2010; Bass and Bass, 2009). Thus, Lean leadership research offers an opportunity for the empirical investigation of concepts proposed by current leadership theories. As such, the following research question can be posed: how can general leadership theories be tested and refined in lean systems?

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Appendix A - Leaders' personal attributes by Leadership Theory

Personal attributes	AL	LMX	CL	DL	RL	TL	SL	SIT
Personality traits								
Value follower	X							
Responsibility	X							
Awareness	X						X	X
Discipline	X							X
Self awareness	X							X
Transparency	X							
Adaptiveness		X						X
Engagement	X		X				X	
Visionary						X		
Integrity							X	
Modesty/Humbolt							X	
Empathy							X	X
Fairness							X	
Skills								
Relationship development	X	X					X	X
Situational analysis		X			X		X	
Administrative skills		X	X					
Vision building			X					X
People management			X					X
Stewardship							X	
Communication					X	X		
Delegation						X		X
Empowerment						X	X	X
Teaching						X		X
Listening						X	X	X
Motivation						X		X
Persuasion						X	X	X

3. LEAN LEADERSHIP COMPETENCIES: A MULTI-METHOD STUDY

Purpose: this study defines the individual leadership competencies that are necessary to implement and sustain lean systems, based on a multi-method approach.

Design/methodology/approach: data collection involved a literature review of lean competencies, interviews with four lean experts, and an empirical survey answered by 91 respondents, who represented companies from several sectors. These techniques provided a mix of qualitative and quantitative data, which set a basis for identifying a list of competencies and discussing its validity.

Findings: sixteen lean leadership competencies were identified and validated, in terms of content validity, face validity, and predictive validity. Regarding this latter validity type, the survey results indicated that the competencies are positively associated with organizational maturity level of lean, and leaders' maturity with lean systems.

Practical implications: the identified list of competencies is a basis for the development of lean leadership development programs. The list may also support the design of tools for assessing the competencies of leaders in lean companies.

Originality/value: a list of 16 lean leadership competencies was developed based on a verifiable research method that used a mix of data collection techniques. This methodological approach is a distinctive characteristic in comparison with earlier studies, which did not include an empirical validation of the competencies.

Key words: Lean Production, Leadership, Leadership Development, Behavior

3.1 INTRODUCTION

Although the importance of leadership has been recognized implicitly since the early descriptions of the Toyota Production System (TPS) (Sugimori et al., 1977; Monden 1998; Schonberger, 1982), the understanding of TPS was focused on the tools and techniques (Shah and Ward, 2003).

Lean Production Systems (LPS), originated from the TPS, have been adopted in several sectors, and their implementation involves various difficulties as well as organizational changes (Nordin et al., 2012; Achanga et al., 2006). Among these difficulties, those related to leadership are frequently mentioned (Marodin and Saurin, 2015a; Alagaraja, 2014).

Emiliani (2003) argues that LPS philosophy and principles require that leaders have particular behaviors and competencies. In another study, Emiliani and Stec (2005) argue that lean organizations should be managed based on certain beliefs that drive the behaviors, which, in turn, are associated with managerial competencies.

Nevertheless, many publications about leadership in a LPS (Liker and Convis, 2012; Spear, 2004), have not been carried out as academic research and are mostly based on their authors' own experiences. Other studies, despite pointing towards leadership characteristics such as behaviors, attitudes, roles, and responsibilities, (e.g. Emiliani, 2003; Emiliani and Stec, 2005; Liker and Ballé, 2013), do not present a verifiable research method to support their findings.

Thus, some knowledge gaps have not yet been addressed from a scientific perspective supported by empirical research. This criticism applies, for instance, to the identification of competencies of leaders involved in LPS. As another drawback, lean leadership studies supported by empirical data are mostly case studies (e.g. Liker and Ballé, 2013; Spear, 2004). This hinders generalizations about findings related to what the lean leadership characteristics are. Furthermore, there is a lack of empirical evidence linking the level of leaders' competencies development and operational results.

In order to address these gaps, this study aims to identify and validate the necessary competencies to perform the lean leadership role. Boyatzis (2008) defines competency as a capability or ability and describes it as a set of related but different behaviors organized around intentions. Behaviors are manifestations of the intent, as appropriate in various situations (Boyatzis, 2008). According to the same author, a competency requires both actions and intentions, which can be inferred from the observable behaviors. Therefore, the research question investigated in this study is stated as follows: "what are the leadership competencies required to support a LPS implementation?" This question is investigated based on a multi-method approach, which provided a mix of qualitative and quantitative evidence. In this study we assume that competencies mentioned by several authors of TPS, like Spear (2004), Liker and Convis (2012), Liker and Ballé (2013), are relevant for lean, since it was originated from that production system, and considered as LPS literature.

3.2 LEADERSHIP IN A LPS

Although the topic of leadership in organizations has been studied for over 50 years (Yukl, 2010), the focus on leadership in LPS is relatively recent (Found and Harvey, 2007). Indeed, many recent studies have spotted effective leadership as a critical factor for a successful lean implementation (Marodin and Saurin, 2015a; Alagaraja, 2014). Table 3.1 presents an overview of the literature about leadership in LPS.

Table 3.1 - Overview of leadership literature in LPS

No.	Authors	Is leadership the main subject? (Yes/No)	Research approach	Focus	Main contribution
1	Achanga et al. (2006)	No	Case study	Leadership as a critical factor	The critical factors for LPS implementation are identified and leadership is among them.
2	Bhasin (2012)	No	Survey and case studies	Leadership as a critical factor	It explores the design of a strategy for implementing LPS and the importance of leadership.
3	Found and Harvey (2007)	Yes	Theoretical	Roles and responsibilities of lean leaders	It discusses whether leadership style influences a lean implementation. It also discusses the change in leadership role during an implementation.
4	Holmemo and Ingvaldsen (2015)	Yes	Case study	Leadership as a critical factor	Through 5 case studies, the article discusses the lack of middle managers' involvement in LPS implementation.
5	Al-Najem, Dhakal and Bennet (2012)	Partially	Theoretical	Leadership as a critical factor	It studies the importance of leadership in a LPS implementation from a framework of culture lean assessment
6	Hartwell and Roth (2010)	Yes	Case study	Leadership as a critical factor	The article presents a case study of a LPS implementation and discusses the role of leadership in it.

7	Liker and Ballé (2013)	Yes	Case study	Roles and responsibilities	It presents the role of leadership for people development. Based on the authors' own experience in Toyota.
8	Mann (2009)	Yes	Theoretical	Leadership as a critical factor	It proposes a leadership framework that covers all hierarchical levels in an organization.
9	Ballé, Bouthillon (2011)	Yes	Case study	Roles and responsibilities	The article discusses, from a case study, the role of leadership in a lean construction implementation.
10	Goodridge (2015)	Yes	Case study	Roles and responsibilities	It proposes a list of leadership practices from data collected in interviews, workshops and document reviews.
11	Alagaraja and Egan (2013)	Partially	Theoretical	Leadership as a critical factor	It proposes a framework of people development where leadership is one of the three categories of analysis.
12	Emiliani (2003)	Yes	Theoretical	Behaviors and competencies	It presents a list of leadership competencies required in a LPS implementation.
13	Emiliani and Stec (2004)	Yes	Theoretical	Leadership development	It proposes the use of Value Stream Mapping (VSM) for identification of leaders' improvements.
14	Emiliani and Stec (2005)	Yes	Case study	Leadership as a critical factor	It discusses leaders' failures in LPS implementation.
15	Marodin and Saurin (2015a)	No	Survey	Leadership as a critical factor	Leadership is cited as a factor to reduce the impact of various barriers on LPS implementation.
16	Alagaraja (2014)	Partially	Theoretical	Leadership as a critical factor	It discusses the importance of people's development. The article identifies leadership as a facilitating factor for an implementation.
17	Wyton and Payne (2013)	No	Case study	Leadership as a critical factor	The article presents, from a case study, the learning improvements about LPS with action learning approach.
18	Poksinska, Swartling and Drotz (2013)	Yes	Case study	Roles and responsibilities	It discusses the changes in the leaders' daily routine in a LPS implementation.
19	Liker and Convis (2012)	Yes	Theoretical/Case study	Leadership development	It presents a framework for leadership development and a case.

20	Liker and Trachilis (2014)	Yes	Theoretical	Leadership development	It presents a framework for leadership development and a case.
21	Emiliani (1998)	Yes	Theoretical	Behaviors and competencies	The article develops the concept of lean behavior as an important element to be considered in a LPS implementation.
22	Spear (2004)	Yes	Case study	Leadership development	It describes the development of a new manager in Toyota.

Table 3.1 indicates that the selected publications whose main topic is leadership are either descriptions of cases or theoretical studies. It also indicates that most of the studies are focused on the manufacturing industry, which may have an influence on the relative importance of the competencies and ways of deploying them. In addition, 50% of the publications approach leadership as a critical factor for LPS, highlighting the distinctive roles and responsibilities of leaders in lean systems. Lists of leadership behaviors or competencies are presented in two papers (Emiliani, 2003; Emiliani, 1998). As a drawback, in both studies, Emiliani does not specify how the lists of behaviors and competencies were identified, nor does he empirically validate the lists.

3.3 RESEARCH METHOD

3.3.1. Overview

This research was divided into four sequential steps: (i) a literature review to develop a preliminary list of competencies and their descriptions; (ii) a refinement of these descriptions with lean experts; (iii) an analysis of the level of agreement of these competencies with core lean principles; and (iv) an empirical validation of these competencies with a fairly large sample of practitioners.

Validity is a fundamental element in scientific research and, in this study, we were concerned with the validation of several constructs – i.e. the lean leadership competencies. Three validation types were encompassed: face validity, content validity, and predictive validity (Figure 3.1). According to Trochim et al. (2015), face validity refers to the analysis of whether the definition of the construct looks good, and it is essentially subjective, usually relying on expert’s assessment. Content validity checks the construct against the relevant content domain

assuming that the content domain is well detailed (Trochim et al., 2015). As to predictive validity, it assesses the construct's ability to predict something it should theoretically be able to predict (Trochim et al., 2015).

Research steps	Validation steps	Type of validity	Criteria
(i) A literature review to develop a list of competencies and their descriptions	Competencies identified in the literature	Content validity	Criteria for literature review and identification of competencies
(ii) Refinement of the lean leadership competencies descriptions with experts	Competencies relevance and writing	Face validity	Interviews with LPS experts
(iii) Verification of the level of agreement of lean leadership competencies with core lean principles	Conceptual-theoretical	Content validity	Adherency to the LPS Principles
	Survey instrument	Content validity	Pre-test with scholar and professionals Correlation with experience time with LPS (Leader) Correlation with academic background (Leader)
(iv) Empirical validation of the lean leadership competencies	Empirical	Predictive validity	Correlation with professional experience time (Leader)
			Correlation with maturity level of the LPS (Organization) Correlation with performance indicators in the area where LPS was implemented (Organization) Correlation with experience time with LPS (Organization)

Figure 3.1 - Overview of the validation types used in the study

3.3.1. Literature review to develop a list of competencies and their descriptions

The search for papers that could contribute to competencies identification was based on literature identified in a database search using the terms “lean” and “competencies” on July 30th, 2015. The following databases were used: Scopus, Emerald Journals, Sage Journals, Springer Link, IEEE Journals, Willey on line Library, and Web of Science. The search was restricted to papers in English, without being restricted to any publication date. Fifty-eight articles were identified and those whose main subject was not “lean” were ruled out. This narrowed down the selection to 18 articles. These papers were entirely read, and the ones not contributing for the identification of competencies were eliminated. At the end of this process, 11 papers were left.

In these 11 papers, an analysis was made to spot excerpts of text that pointed out examples of leaders’ actions and intentions that contributed to implementing lean principles. The emphasis on actions and intentions was due to the previously mentioned definition of competency proposed by Boyatzsis (2008).

For instance, the following excerpt was extracted from Liker and Hoseus (2009): “...problems identified are solved by getting a cross-functional and cross-level team together and allowing them to use the problem-solving process and empowering them to make the decisions necessary to take care of the problems.”

Based on this excerpt, we inferred that a leadership competency could be stated as “identify and solve problems with the teams using the PDCA principle”. The excerpt was associated with an action (i.e. “an empowered team solving a problem using problem-solving process”), and an intention (i.e. “to develop people”). As a result of this process, 19 lean leadership competencies were identified.

The competencies were described as pragmatically and objectively as possible, so as they could make sense and resound with practitioners. In fact, descriptions of competencies in generic and ambiguous ways are often presented as a criticism to existing competency models (Teodorescu and Binder, 2004).

3.3.2. Refinement of the lean leadership competencies descriptions with experts

The preliminary list of competencies was discussed and refined with four lean experts, being two consultants and two scholars, which provided balanced practical and theoretical perspectives.

Two questions were asked for each competency in order to refine the list with the experts: (i) whether the competency was relevant for a lean leadership, and (ii) whether the competency was clearly described. Experts were invited to point out reasons and suggestions for addressing any disagreements they had in relation to the list. This process narrowed down the number of competencies from 19 to 16.

3.3.3. Verification of the level of agreement of lean leadership competencies with core lean principles

The 16 identified leadership competencies were analyzed in light of the lean principles proposed by Liker (2004). The analysis checked for conceptual consistency between the description of the principles and the statement of the competencies.

3.3.4. Empirical validation of the lean leadership competencies

3.3.4.1. Survey

A questionnaire containing 97 questions was designed and sent to the respondents, who were asked to identify a lean implementation they were acquainted with. Respondents should assess both implementation and leadership, considering that the leaders could be themselves. The survey questionnaire was divided into four sections:

- i) Characterization of the analyzed leader. Questions were asked about the leader's profile (hierarchical position, experience in LPS, educational and professional background) as well as their level of leadership competency development. Each respondent assessed the development level of each competency ranking from 1 (little developed) to 5 (very developed);

- ii) Characterization of the analyzed system in which LPS was implemented. The system could be a cell, an assembly line, a department or a whole plant. The questions about the analyzed system aimed to assess the performance level of its indicators over the last three years. In order to assess it, a scale from 1 (worsened a lot) to 7 (improved a lot) was suggested, being 4 the indicator of unaltered performance. Eleven performance indicators were selected based on proposals by Shah and Ward (2003) and Rahman et al. (2010), in addition to three others related to Human Resource Management (HRM): safety, absenteeism and turnover;
- iii) Characterization of the company. Questions were asked about the presence of a formal LPS project, LPS maturity level in the company, company sector, among others. Based on Hallam and Keating (2014), the maturity level could be assessed in a 5 level range, from 1 (little knowledge of lean; ongoing random improvement activities in some areas) to 5 (exceptional, well defined and innovative approach; it is applied across the supply chain; acknowledged as the best practice);
- iv) Characterization of the respondent. This was useful to identify the respondent's relationship with the analyzed leadership, in case the assessment had not been about him or her. Questions were also asked about the respondent's experience and level of knowledge in LPS.

A pre-test with two scholars and two practitioners was done in order to test the questionnaire, its questions writings and scales. Their feedback and suggestions were included in the version of the questionnaire that was sent to potential respondents.

3.3.4.2. *Sample*

The main criterion for selecting the respondents was that these had either personal experience conducting a LPS implementation in the previous 12 months or followed it up closely enough in order to assess a leader's performance in this process.

An electronic invitation to take part in the research was sent to 15,200 contacts of a LPS executive training database of the most important research universities in the South of Brazil,

which included mostly professionals from companies in general, but also students, professors, and consultants. Among these contacts, 145 people responded positively both in terms of selection criterion and availability to participate.

The final sample consisted of 91 valid answers (63%). In brief, it is possible to characterize the respondents' group profile as academically qualified (all of them have a college degree and 32% are post-graduated), professionally experienced (54% with more than 15 years' experience), and acquainted with lean theory and practice (72% with more than 4 years' experience in LPS, and 40% considered themselves experts in LPS).

Concerning the profiles of the leaders evaluated by respondents, despite being distributed across several hierarchical levels, they are predominantly made up of professionals who hold managerial positions (60%). The leaders have a college degree (98%), and most of them attended post-graduation courses (65%). These are also professionals with a fairly good professional experience and with LPS as well (48% with more than 5 years' experience).

In terms of the assessed companies, they are in general large-sized companies (73% with more than 250 employees), focused on manufacturing (78%), formally involved in lean projects for at least 3 years (76%), stand in intermediate maturity level of development of lean (42%), and have performance indicators related to the topic (68%). Most of the companies used consultancy support (58%) in their LPS implementation. Appendix 1 presents a summary of the respondents' and leaders' profiles, as well as a more detailed characterization of the assessed companies.

3.3.4.3. Data analysis of the survey

To empirically test the predictive validity of the lean leadership competencies, we relied into an individual and an organizational perspective. First, we assumed that leaders that have a high degree of those competencies would also have more knowledge and experience with LPS. More time spent in training and acquiring formal knowledge about LPS and also active participation in implementing lean practices would help to develop those competencies.

Second, the fact that the leader is embedded into a working environment that has a more mature LPS implementation would expose them to develop their leadership competencies. Managers get more, not less, committed to and involved in the lean implementation in high maturity plants (Netland, 2016). Thus, we proposed to test the two hypotheses as follows:

H1) Lean leadership competencies are positively associated with leader's maturity level in LPS

H2) Lean leadership competencies are positively associated with organizational maturity level of LPS

Three criteria were defined to measure the organizational maturity level of LPS implementation, namely: degree of LPS implementation, operational performance, and company's experience time with LPS. In turn, other three criteria measured the leader's maturity level in LPS: leader's experience time with LPS, leader's academic background, and leader's professional experience time. We carried out the data analysis in two steps. First, a Principal Component Analysis (PCA) was conducted, with Varimax orthogonal rotation, in order to reduce the effects of correlations between variables (i.e. lean leadership competencies) as well as to obtain one underlying construct that represented the overall degree of the lean leadership competencies.

Second, we used Pearson bi-variate correlations (Pearson's r) to test the association between variables and validate the proposed hypothesis. When appropriate, the bi-variate correlations were conducted with all variables, as well as with the reduced construct that emerged from the PCA. This procedure was used when testing the association between lean leadership competencies and operational performance metrics, because the latter have multiple items that were used to measure, instead of only one (such as LPS maturity level, for example).

3.3.5. Review of the survey data with respondents

The results of the survey were presented in a feedback meeting with a group of respondents from the survey. An invitation was sent to the 91 original respondents and 6 of them accepted it. The meeting lasted 4 hours, and it was audio recorded and transcribed. The researcher presented the results for each of the four sections of the questionnaire, emphasizing

findings related to the two hypotheses. As suggested by Voss, Tsikriktsis, and Frohlich (2002), participants were asked to offer their views on the findings, especially in terms of their accuracy and possible interpretations. Furthermore, practical implications of the results were pointed out by respondents.

3.4 RESULTS AND DISCUSSIONS

3.4.1. Proposed list of lean leadership competencies

The results of the first three steps described in the research method are presented in this section. Table 3.2 shows the list of the 16 competencies that emerged from the literature review and were refined by experts, as well as their association with the 14 lean principles proposed by Liker (2004).

Table 3.2 - Leadership competencies and their association with lean principles

	Lean Leadership Competencies	References used in the literature review	Agreement with references used (% of total number of references)	Lean Principles	Agreement with lean principles (% of total number of principles)
C1	Identify what adds value to internal and external clients	a, b, c, d, e, f, g, h, i, k	91%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	100%
C2	Identify and solve problems with their teams using the PDCA principle (coaching)	a, b, d, e, g, i, j, k	73%	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14	93%
C3	Use continuously lean practices and principles	a, b, c, d, e, f, g, k	73%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	100%
C4	Manage with emphasis on value flow rather than on isolated operations	a, b, c, d, e, h, j, k	73%	2, 3, 4, 5, 9, 11, 13, 14	50%
C5	See the problems with your own eyes (based on data and facts)	a, b, d, e, g, h, i, k	73%	2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14	86%

C6	Lead through example	a, b, c, d, e, g, h, i, k	82%	5, 7, 9, 10, 12, 13, 19	50%
C7	Stabilize processes	a, b, e, h	36%	2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14	93%
C8	Provide value-added information clearly and objectively	a, b, c, d, e, h, j, k	73%	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 13, 14	86%
C9	Put the group's interests above the individual ones	a, b, c, d, e, g, i, j, k	82%	5, 8, 9, 10, 13	36%
C10	Develop and implement guidelines, plans and policies aiming at people's development	c, d, e, g, i	45%	5, 9, 10, 13, 14	36%
C11	Practice self-development as well as professional and personal continuous evolution	a, b, c, d, g, i, k	64%	5, 9, 12, 13	29%
C12	Identify and manage barriers during lean production journey	c, d, e, f	36%	1, 5, 6, 7, 8, 9, 10, 11, 13, 14	71%
C13	Practice lean as an interrelated system of principles and practices	c, d, e, g, g, h, k	64%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	100%
C14	Develop actions based on long term views	a, c, e, f, i	45%	1, 2, 4, 5, 6, 9, 10, 11, 13, 14	71%
C15	Develop actions that, based on ethical principles, respect the community, the environment and the workers' safety	a, d, e, f, g, j	55%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14	93%

C16	Develop innovative and challenging actions	b, c, d, e, f, g, i, j, k	82%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14	93%
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References: a - Emiliani (2003); b - Hilton and Sohal (2012); c - Alagaraja (2014); d - Liker and Hoseus (2009); e - Emiliani and Stec (2004); f - Emiliani and Stec (2005); g - Spear (2004); h – Found, Van Dun and Fei (2009); i - Dombrowski and Mielke (2014); j – Poksinska, Swartling and Drotz (2013); k - Wyton and Payne (2014).

Lean Principles (Liker, 2004): 1 - Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals; 2 - Create continuous flow to bring problems to the surface; 3 - Use pull systems to avoid overproduction; 4 - Level out the workload (Heijunka); 5 – Build a culture of stopping to fix problems, to get quality right first time; 6 – Standardized task are the foundation for continuous improvement and employee empowerment; 7 – Use visual control so no problems are hidden; 8 - Use only reliable, thoroughly tested technology that serves your people and process; 9 - Grow leaders who thoroughly understand the work, live the philosophy and teach it to others; 10 - Develop exceptional people and teams, who follow your company’s philosophy; 11 - Respect your extended network of partners and suppliers by challenging them and helping them to improve; 12 – Go and see for yourself to thoroughly understand the situation (Genchi genbutsu); 13 - Make decisions slowly by consensus and thoroughly considering all options, implement decisions rapidly (Nemawashi); 14 – Become a learning organization through relentless reflection (Hansei) and continuous improvement (Kaizen).

The studies by Liker and Hoseus (2009), and Emiliani and Stec (2004) were the ones that contributed the most with 14 and 15 competencies, respectively. The competencies were explicitly presented in only two articles (Emiliani, 2003; Emiliani and Stec, 2004), although the methods for their identification have not been detailed. In other studies, the terms skills, attributes (Hilton and Sohal, 2012) or factors that influence lean implementation (Alagaraja, 2014; Nordin et al., 2012) were used. For example, Alagaraja (2014) identified the top management’s short-term view as well as the lack of communication skills as factors that hinder LPS implementation. Such factors have been reinterpreted as leadership competencies.

Based on Table 3.2, competencies were considered to be associated with, at least, 4 principles, and, at most with all of them (i.e. 14). On the one hand, C11 was associated with only four principles. This can be due to the *personal* continuous evolution included in the scope of C11, which values individual traits in addition to the organizational characteristics emphasized by the lean principles. On the other hand the competencies associated with all principles were C1, C3, and C13. These competencies can have a higher degree of importance than others, assuming that the analyzed associations correspond to a proxy measure of importance.

Table 3.2 also indicates that some competencies were relatively much more associated with the principles than mentioned in the reviewed literature – i.e. C7 and C14. This suggests that the importance of these competencies has been underestimated by many studies, which can result from the low development of the competencies in real settings. In turn, C9 and C11 are

relatively much more stressed by literature than associated with the principles. This may be due to the aforementioned interpretation regarding C11, which also applies to C9. Both competencies seem to be significantly related to individual traits, which are not emphasized by the lean principles. This indicates an opportunity to develop lean theory further.

Although lean theory is well known for emphasizing the role of the context on people's behavior (e.g. rather than emphasizing who made a mistake, lean is concerned with the role played by systems), it seems that mainstream lean theory has not paid sufficient attention to the individuals' personality traits and unique personal qualifications.

3.4.2. Empirical validation of the lean leadership competencies

3.4.2.1. Leader's maturity level in LPS and lean leadership competencies

The first test was the association between leader's experience time with LPS and the first principal component of competency development, which represents 46% of the variance of the construct. The correlation was positive and significant of 0.510 (p-value = 0.000). Indeed, if the leader's competencies develop as their experience with LPS increases, this is in line with the leadership development practice through coaching and mentoring by Toyota. In Toyota, the coach is always someone with wide experience in the system and considered to have advanced leadership competencies (Spear, 2004). Furthermore, a continuous improvement environment could be a contributing factor to this result, since the more experienced the leader, the more exposed they will be to problem solving using the scientific method.

The second test was the association between leader's formal academic level and lean leadership competencies. The majority of the assessed leaders have a graduate degree (65%) and almost all of them also have a college degree (98%). Pearson's r between the first principal component of competency development and the leader's academic background was 0.251, being positive and significant (p-value = 0.009). Formal education is well known for developing logic reasoning, abstract, and critical thinking (Ernst and Monroe, 2007), which are assets for all lean competencies.

The third test was the positive (Pearson's $r = 0.208$) and significant association (p-value = 0.035) between leader's professional experience and lean leadership competencies. The

assessed leaders are experienced professionals, having an average of 14.4 years' experience, and 68% with more than 10 years' experience.

The association of competency development with the leader's experience time with LPS, adding to their academic background and professional experience, points to the importance of leaders and companies' Human Resources (HR) in planning leadership development. Alagaraja and Egan (2013) discuss the assessment of training needs, skills evaluation, and systematic leadership development as examples of initiatives from HR staff to support LPS efforts.

In sum, all the three variables that were used to test H1 were significantly positive. Thus, we concluded that the developed list of lean leadership competencies is positively associated with leader's maturity level in LPS, and H1 cannot be rejected.

3.4.2.2. *Organizational maturity level of LPS and lean leadership competencies*

The first variable that was used to test the association of organizational maturity level of LPS and lean leadership competencies was the degree of LPS implementation. The correlation between lean leadership competencies and degree of LPS implementation in the company was positive and significant at 0.257 (p-value = 0.006).

The second variable that was used to test the association of organizational maturity level of LPS and lean leadership competencies was the operational performance. Pearson's r between each competency and each indicator was calculated, which generated a matrix of correlations (Table 3.3). The analysis of the matrix indicates that:

1. All competencies have significant correlations with at least one indicator, which suggests that the efforts to develop competencies can result in tangible benefits associated with operational indicators;
2. All significant correlations are positive, indicating that efforts to develop all competencies, rather than only some of them, are recommended;
3. Leaders should be encouraged to develop improvements in Safety (SA), and Quality (QFT) issues due to the high number of significant correlations (13 and 11, respectively) between the competencies and the safety and quality indicators. In the previously mentioned feedback meeting, participants reported that these results made sense, since

improvements in safety and quality require teamwork at the front-line and a high level of social interaction between leaders and followers in order to change behaviors;

4. Absenteeism (AB) and Inventory Turns (IT) indicators did not have significant correlations with any competency, while Turnover (TO) indicator with only one competency. These metrics are likely to be strongly influenced by other factors. For instance, concerning IT, the characteristics of the company's market demands or the type of product could have exerted strong influence as well as the company's position in the supply chain. This interpretation was highlighted by the group of participants of the feedback meeting. Furthermore, these findings are in line with the conclusions of a recent empirical survey in a similar sample of Brazilian companies (Marodin et al., 2016), which found that IT and TO metrics did not have significant improvement as a result of lean implementation;
5. Indicators that have no significant correlations with the competencies could be dependent on technical variables to a larger extent. For example, Lead Time (LT) indicator, which is impacted by four competencies (C1, C3, C13, C14), might be more dependent on technical variables (e.g. process and machine specifications) than on social variables (e.g. team interactions).

Table 3.3 - Matrix of correlations between competencies development and operational performance indicators

	WP**	EE	IT	OTD	CS	QFT	WS	LT	SR	AB	TO
C1	Non-signif.	Non-signif.	Non-signif.	0.273 (0.004)*	0.260 (0.006)	0.215 (0.020)	0.279 (0.004)	0.229 (0.015)	0.206 (0.025)	Non-signif.	Non-signif.
C2	Non-signif.	0.198 (0.030)	Non-signif.	Non-signif.	0.174 (0.050)	0.198 (0.030)	0.323 (0.001)	Non-signif.	Non-signif.	Non-signif.	Non-signif.
C3	0.299 (0.002)	Non-signif.	Non-signif.	0.196 (0.031)	Non-signif.	0.262 (0.006)	0.228 (0.015)	0.211 (0.022)	0.174 (0.050)	Non-signif.	Non-signif.
C4	0.289 (0.003)	Non-signif.	Non-signif.	0.317 (0.001)	Non-signif.	Non-signif.	0.180 (0.044)	Non-signif.	Non-signif.	Non-signif.	Non-signif.
C5	Non-signif.	0.205 (0.026)	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.

C6	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.	0.184 (0.040)	0.288 (0.003)	Non-signif.	Non-signif.	Non-signif.	Non-signif.
C7	0.223 (0.017)	Non-signif.	Non-signif.	0.238 (0.011)	0.258 (0.007)	0.350 (0.000)	0.357 (0.000)	Non-signif.	0.191 (0.035)	Non-signif.	0.187 (0.038)
C8	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.	0.199 (0.029)	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.
C9	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.	0.203 (0.027)	Non-signif.	Non-signif.	Non-signif.	Non-signif.
C10	Non-signif.	0.187 (0.038)	Non-signif.	0.234 (0.018)	0.203 (0.027)	0.253 (0.008)	0.372 (0.000)	Non-signif.	Non-signif.	Non-signif.	Non-signif.
C11	Non-signif.	0.251 (0.008)	Non-signif.	0.272 (0.005)	0.189 (0.036)	Non-signif.	0.184 (0.040)	Non-signif.	Non-signif.	Non-signif.	Non-signif.
C12	Non-signif.	Non-signif.	Non-signif.	Non-signif.	0.185 (0.040)	0.259 (0.007)	0.185 (0.040)	Non-signif.	0.191 (0.035)	Non-signif.	Non-signif.
C13	0.33 (0.001)	Non-signif.	Non-signif.	0.281 (0.030)	0.175 (0.049)	0.293 (0.002)	0.203 (0.027)	0.212 (0.022)	0.212 (0.022)	Non-signif.	Non-signif.
C14	Non-signif.	Non-signif.	Non-signif.	0.174 (0.050)	0.179 (0.045)	0.213 (0.021)	0.203 (0.027)	0.214 (0.021)	Non-signif.	Non-signif.	Non-signif.
C15	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.	0.260 (0.006)	Non-signif.	Non-signif.	Non-signif.	0.184 (0.040)
C16	0.254 (0.008)	0.189 (0.036)	Non-signif.	Non-signif.	0.236 (0.012)	0.242 (0.010)	Non-signif.	Non-signif.	Non-signif.	Non-signif.	Non-signif.

*Number in parenthesis is the p-value;

** Workforce Productivity (WP); Equipment Efficiency (EE); Inventory Turns (IT); On-time-delivery (OTD); Customer satisfaction (CS); Quality-Right at the first time (QFT); Work safety (WS); Lead time (LT); Scrap and rework (SR); Absenteeism (AB); Turnover (TO).

The association between lean leadership competencies and operational performance indicators was also performed using a reduced number of variables of performance metrics. The PCA was conducted to find the underlying constructs for the 11 performance metrics, and the first component extracted contains 34% of the total variance of the construct. Pearson's r was calculated between the first principal component of competency development and the first principal component of the performance indicators. A significant correlation equal to 0.346 (p-value = 0.004) was found.

The third variable that was used to test the association of organizational maturity level of LPS and lean leadership competencies was the company's time experience with LPS. There was no significant correlation between the first principal component of leadership competencies and the company experience time with LPS. This result can be related to the difficulties the companies involved in this study have to sustain LPS initiatives and outcomes over time this interpretation is in line with earlier studies (Bhasin 2012; Hines et al., 2011).

Another possible interpretation is to relate these results to high leaders' turnover as well as to the lack of formal mechanisms of transfer and record of tacit knowledge. This turnover can result from the influence of external contextual factors, such as the lack of specialized workforce. In fact, one of the questions was about the availability of specialized workforce and the result was found in the middle of the scale (2.0) from 1 (low availability) to 3 (high availability).

In fact, companies that seek to implement LPS may be recruiting managers from other companies. This was the case of two of the participants in the feedback meeting, who had been working at their present companies for less than two years, even though they had a previous longer experience with lean in other companies. Moreover, 51% of the assessed leaders had less than 3 years' experience with LPS. In sum, two of the three variables that were used to test H2 were significantly positive. Thus, we concluded that the developed list of lean leadership competencies is positively associated with organizational maturity level of LPS, and thus H2 cannot be rejected. Figure 3.2 presents a summary of the hypotheses tested for the empirical validation.

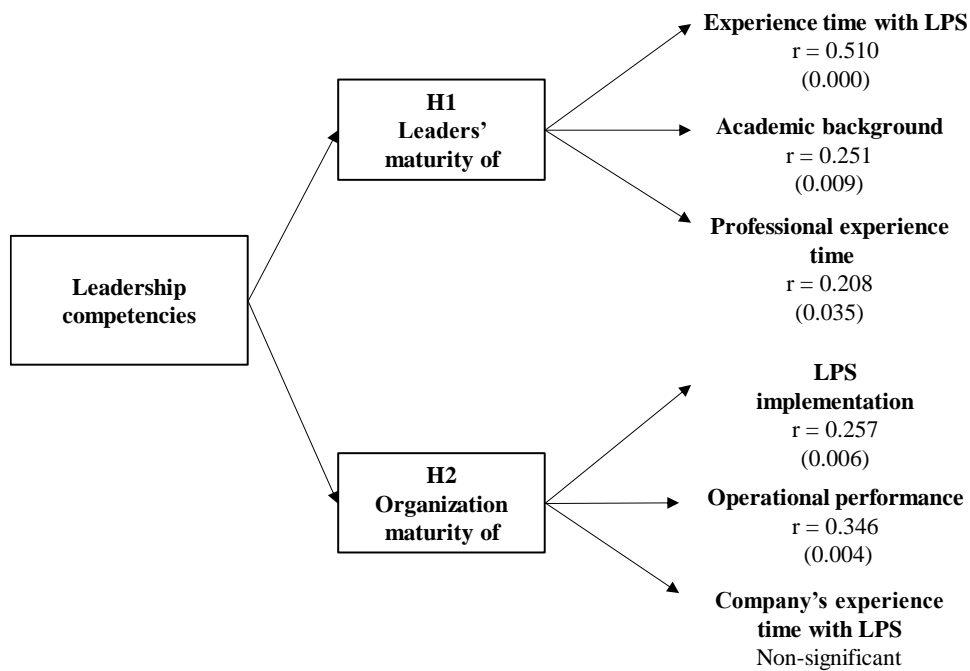


Figure 3.2 - Summary of hypotheses tested

3.5 CONCLUSIONS

3.5.1. Contributions of this study

The research question addressed in this study was stated as follows: “what are the leadership competencies required to support a LPS implementation?” Thus, a list of 16 competencies was developed based on a verifiable research method that used a mix of data collection techniques, which provided both theoretical and empirical support. This is a distinctive characteristic in comparison with earlier studies of LPS leadership.

The findings indicate the validity of the 16 identified competencies, based on a multi-method approach. Furthermore, an important result from the empirical research is related to the positive and significant correlations between lean leadership competencies and leader’s maturity level in LPS as well as organizational maturity level of LPS.

The empirical findings of this study, which suggest a positive correlation between the development of competencies and operational performance, should be interpreted as encouragement for managers when making decisions about whether to invest in developing competencies for LPS implementation. This study offered insights into the understanding of the sustainability of a LPS, indicating that leadership competencies play an important role in the

maturity of a LPS and its performance. Furthermore, the identified list of lean leadership competencies identified sets a basis for designing formal leadership development programs as well as to the development of tools to assess and manage them.

3.5.2. Limitations

Some limitations of this research study should also be noted. First, the survey did not account for some contextual variables, such as competitiveness, macro economic scenario, and position of the company in the supply chain, among others. Second, the characteristics of the sample itself limit generalizations, both in terms of the companies and leaders assessed. Third, different terms and criteria for searching the studies in the literature review could have resulted in a different selection of studies.

3.5.3. Future studies

Some opportunities for further research can be stressed, such as: (i) the investigation of the impacts of competency development in other samples of companies and leaders; (ii) analyses of the competencies development in different hierarchical levels in the organization and in companies with different lean maturity levels; (iii) analyses of how leaders' social (e.g. communication) and technical skills affect the competencies; (iv) the investigation of the necessary competencies in variants of the lean system, such as Lean Six Sigma and Lean Agile, and (v) refinement of the identified list of competencies, by checking it against general leadership theories, which have been pointed out as relevant for lean leadership (e.g. transformational leadership, and servant leadership).

Lastly, it is worth noting that other methodologies could be used to identify the competencies of lean leaders and their correlations with different aspects of a LPS. In particular, we suggest the use of systems thinking approaches (e.g. system dynamics models), since these can shed light on the relationships between the competencies themselves and between these and a broad range of contextual factors.

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4. THE INFLUENCE OF CONTEXT ON LEAN LEADERSHIP COMPETENCIES

Abstract

Although leadership performance in lean systems is known to be influenced by context, the mechanisms linking the contextual factors (CFs) to leadership have not been explored. This study proposes a seven-step method for the analysis of how context influences lean leadership competencies. The distinctive characteristics of the method are: (i) the assessment of the lean leadership competencies for leaders in different hierarchical levels; (ii) the assessment of the dynamics of the CFs over time; (iii) the introduction of the concept of ‘leadership event’ as a unit of analysis; and (iv) the use of causal-loop-diagrams for assessing the interactions between CFs and lean leadership competencies. A case study of a large manufacturer’s plant illustrates the applicability of the method. Based on this study, a model of four typical lean leadership events is proposed (linear, apparently linear, apparently complex, and complex), indicating that lean leadership is an emergent phenomenon that requires adaptive leaders who are capable of navigating across a dynamic context.

Keywords: lean production, lean leadership, context, competencies, complexity.

4.1. INTRODUCTION

The role played by context in lean production (LP) implementation has been widely recognised as relevant, and a number of contextual factors (CFs) have been identified as important for either supporting or hindering LP (e.g. Browning and Heath 2009; Shah and Ward 2003).

Studies about context in LP are usually based on questionnaire surveys (Shah and Ward 2003; Netland 2016; Tortorella et al. 2018). Regardless of the statistically generalisable findings of these surveys, these are to some extent elusive, since there is a unique context in each LP implementation. This occurs because companies using lean are complex socio-technical systems, subject to a large number of diverse elements in dynamic interactions, influenced by the external environment (Soliman, Saurin, and Anzanello 2018). Furthermore, survey-based studies normally take into account a few CFs, which oversimplifies the complex dynamics of lean implementation. Netland (2016) considered four CFs (sector of activity, number of employees, implementation stage, and national culture). Shah and Ward (2003) emphasised

three CFs (unionisation, age of the plant, and size of the plant). Tortorella et al. (2018) investigated two CFs (team size and leader's age).

In turn, Marodin and Saurin (2015) carried out a case study and identified 34 CFs that influenced the barriers to lean. This is in contrast with the number of factors addressed by the mentioned surveys. Considering that these CFs interact between themselves, and not only with lean practices and principles, a holistic analytical method for making theoretical and practical sense of this complexity is necessary.

While context influences all dimensions of LP, this study explores the influence on lean leadership, and more specifically on lean leadership competencies (LLCs). Lean leadership definitions do not acknowledge the influence of context, and they are typically framed as a leader's behaviour according to lean principles (Dombrowski and Mielke 2013; Liker and Convis 2012; Mann 2009; Emiliani 2008). In turn, LLCs are the necessary competencies to perform a lean leadership role (Seidel et al. 2017). A competency embodies measurable knowledge, skills, traits, and behaviours that allow an individual to effectively perform a task in a certain position or job (Marrelli 1998; Boyatzis 1982). A competency also requires both actions and intentions, which can be inferred from the observable behaviours (Boyatzis 2008).

LLCs have been recognised as critical for a successful lean implementation (Camuffo and Gerli 2018; Alagaraja 2014). Although it is well-established that LLCs are influenced by context (Camuffo and Gerli 2018), the mechanisms linking context to lean leadership are not yet well understood, and there is a lack of empirical data arising from qualitative research. The exploration of the said mechanisms also raises the question of the unit of analysis for the observation and sense making of practical instances of LLCs.

Based on this, two research questions (RQ) are addressed by this study: (RQ1) how can the influence of context on LLCs be assessed? (RQ2) Which should be the unit of analysis for exploring the interactions between context and LLCs? RQ1 was addressed through the development of a new method for analysing the influence of context on LLCs. This method was tested in the plant of a large manufacturer, which has been adopting lean as a corporate policy for 5 years. A key element of this method is the new concept of lean leadership event,

which deals with RQ2. Based on extant theory and insights from the test of the method, a model of four types of lean leadership events is proposed, which acknowledges the situational nature of LLCs and sets a basis for framing this construct as an emergent phenomenon.

4.2. LEAN LEADERSHIP COMPETENCIES ADOPTED AS BASIS IN THIS STUDY

In this study, the sixteen competencies proposed by Seidel et al. (2017) are adopted. Differently from earlier studies, which were mostly conceptual and based on their authors' own experiences (e.g. Liker and Convis 2012; Spear 2004), the LLCs by Seidel et al. (2017) had an empirical validation, based on interviews with lean experts and an empirical survey answered by 91 respondents from several sectors. The adopted LLCs are presented in Table 4.1, along with their association with the lean principles defined by (Liker 2004).

Table 4.1 - LLCs and their association with lean principles (based on Seidel et al., 2017)

#	Lean Leadership Competencies	Lean Principles
C1	Identify what adds value to internal and external clients	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
C2	Identify and solve problems with their teams using the PDCA principle (coaching)	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14
C3	Use continuously lean practices and principles	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
C4	Manage with emphasis on value flow rather than on isolated operations	2, 3, 4, 5, 9, 11, 13, 14
C5	See the problems with your own eyes (based on data and facts)	2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14
C6	Lead through example	5, 7, 9, 10, 12, 13, 19
C7	Stabilise processes	2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14
C8	Provide value-added information clearly and objectively	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 13, 14
C9	Put the group's interests above the individual ones	5, 8, 9, 10, 13
C10	Develop and implement guidelines, plans and policies aiming at people's development	5, 9, 10, 13, 14

C11	Practice self-development as well as professional and personal continuous evolution	5, 9, 12, 13
C12	Identify and manage barriers during lean production journey	1, 5, 6, 7, 8, 9, 10, 11, 13, 14
C13	Practice lean as an interrelated system of principles and practices	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
C14	Develop actions based on long term views	1, 2, 4, 5, 6, 9, 10, 11, 13, 14
C15	Develop actions that, based on ethical principles, respect the community, the environment and the workers' safety	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14
C16	Develop innovative and challenging actions	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14

Lean Principles (Liker, 2004): 1 - Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals; 2 - Create continuous flow to bring problems to the surface; 3 - Use pull systems to avoid overproduction; 4 - Level out the workload (Heijunka); 5 – Build a culture of stopping to fix problems, to get quality right first time; 6 – Standardised task are the foundation for continuous improvement and employee empowerment; 7 – Use visual control so no problems are hidden; 8 - Use only reliable, thoroughly tested technology that serves your people and process; 9 - Grow leaders who thoroughly understand the work, live the philosophy and teach it to others; 10 - Develop exceptional people and teams, who follow your company’s philosophy; 11 - Respect your extended network of partners and suppliers by challenging them and helping them to improve; 12 – Go and see for yourself to thoroughly understand the situation (Genchi genbutsu); 13 - Make decisions slowly by consensus and thoroughly considering all options, implement decisions rapidly (Nemawashi); 14 – Become a learning organisation through relentless reflection (Hansei) and continuous improvement (Kaizen).

According to Table 4.1, LLCs are associated with, at least, four principles, and, at most, with all of them (i.e. fourteen). On the one hand, C11 was associated with four principles. This can be due to the *personal* continuous evolution included in the scope of C11, which values individual traits in addition to the systemic emphasis of lean principles. On the other hand, C1, C3, and C13 were associated with all principles. These competencies may have a broader impact on lean systems and then be more important than the others (Seidel et al., 2017).

4.3. RESEARCH DESIGN

4.3.1. Research strategy

This study is framed as an application of Design Science Research (DSR), which involves the development of an innovative artifact to solve a practical problem, and simultaneously provides a prescriptive scientific contribution (Holmström, Ketokivi, and Hameri 2009). DSR has been

promoted as a valuable approach to bridge the gap between theory and practice in the operations management discipline (Van Aken, Chandrasekaran, and Halman 2016). The five typical outputs of DSR are (March and Smith 1995): (i) constructs, which are the key concepts to characterise a problem or a solution; (ii) models, which correspond to the combination of constructs in order to describe interactions between tasks, situations, or artifacts; (iii) methods, which are ways of performing goal-oriented activities; (iv) instantiations, which correspond to the realisation of the artifact in an environment and; (v) theoretical contributions either in terms of the methodological construction of the artifact or in terms of exposing the relationships among elements of the artifact.

In this research, a method is proposed for analysing the influence of CFs on LLCs. The development of the method has both a theoretical and an empirical basis. The literature provided guidance on theoretical gaps, nature of LLCs and CFs. As such, researchers were able to devise an initial draft of the method. As for the empirical basis, the method was tested and refined based on its application in a plant of a manufacturer of automotive components located in the United States. This plant was chosen due to: (i) its large experience of implementing lean, which suggested the existence of plenty of opportunities for the interaction between context and leadership; and (ii) the interest of the lean manager in the research topic, which made him available as the key informant for the data collection.

The method is not limited to any specific organisation type that seeks to implement LP. Considering the method as a product of DSR, it should be interpreted as a generic design which is to be used as a 'design-model by well-trained and experienced designers to make their own context specific design' (Van Aken, Chandrasekaran, and Halman 2016). The generic design should be well-documented enough to enable practitioners to use it as a model for making case-specific designs (van Aken, Chandrasekaran, and Halman 2016).

4.3.2. The method for analysing the influence of CFs on LLCs

The method has 7 steps (Figure 4.1). **Step 1** involves defining the boundaries of the system as well as its initial description, from both a functional and a structural viewpoint. Concerning the definition of boundaries, three criteria are proposed: (i) the chosen system (e.g. a department, cell) has to be experienced in applying lean principles (more than five years), (ii) there should be difficulties in sustaining improvements, and (iii) there should be a multi-faceted dynamic

context. As for the functional characterisation, it can be conducted through flowcharts and process maps, which illustrate interconnections between process stages. The structural characterisation should be based on the elements pertaining to the four sub-systems of the socio-technical system, as proposed by Hendrick and Kleiner (2001): social, technical, work organisation, and external environment. Later steps of the method (i.e. 2, 3, 4, 5, and 6) also offer important complementary information to describe the system, and for the resulting identification of CFs.

Step 2 focuses on the LLCs assessment of the leaders who work within the system boundaries. For the purposes of applying the method, a leader is a professional who holds responsibilities for implementing LP irrespective of their hierarchical position in the organisation (Mann 2009). Therefore, the leadership role can be performed either by a director, an industrial manager, a supervisor, a shop floor team leader, or even by an outsourced consultant.

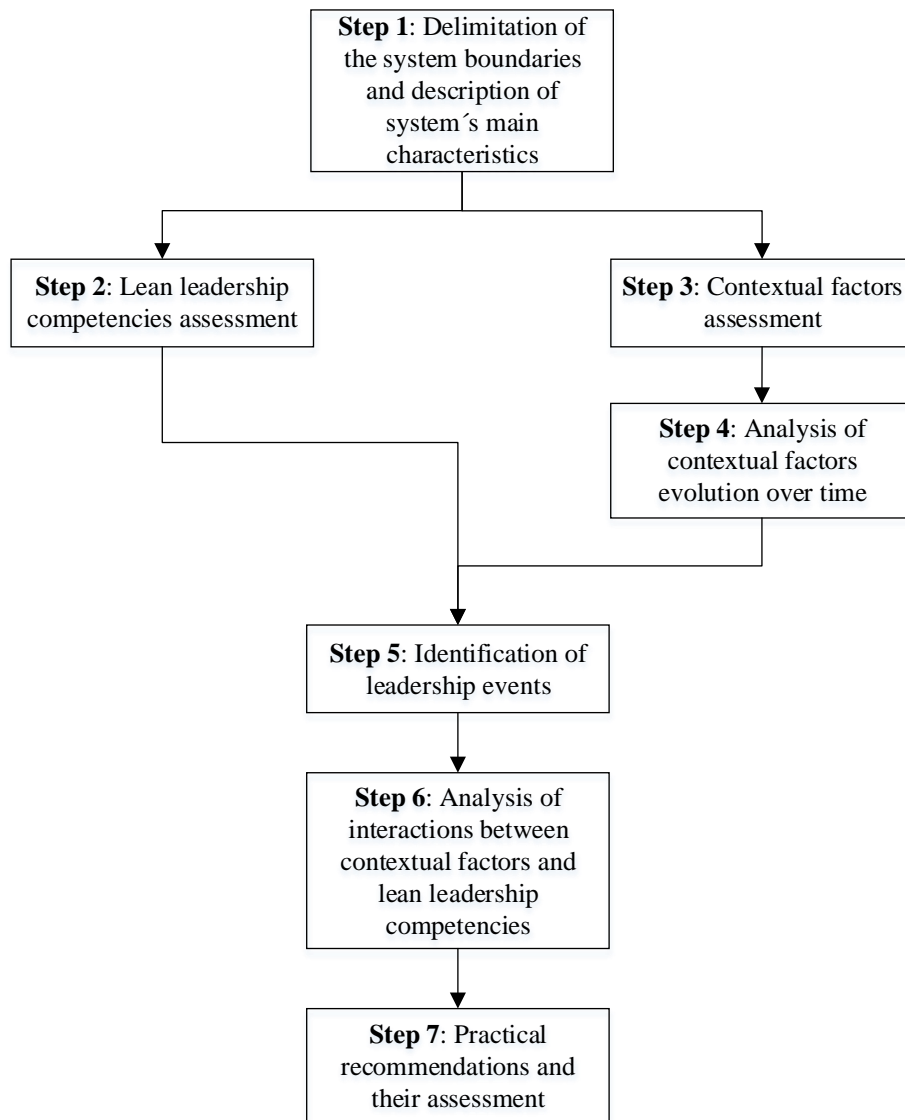


Figure 4.1 - Method for analysing the influence of CFs on LLCs

To assess the LLCs, a questionnaire was developed (Figure 4.2), which contains two parts. In the first part, the respondent, who must be a leader, carries out a self-assessment. If the respondent is not a leader, this section of the questionnaire should not be answered. In the second part, the respondent assesses their leader – hereafter this is referred to as ‘leader’s assessment by followers’. Gaps between self assessment and assessment by followers can point out perception miscalibrations that need to be addressed. In turn, in each of these two parts, there are two questions associated with each competency: one question refers to how well the leader is prepared to apply the competency, and the other refers to how well the leader deploys the competency in practice. Respondents are also requested to offer examples that support their

assessment. These examples may inform the identification of leadership events (see Step 5, below).

COMPETENCY C1 - Identify what adds value for internal and external clients

1.1 How well do you feel prepared (e.g. knowledge and skills) to <i>identify what adds value for internal and external clients?</i>	Very Low	Medium			Very High
	1	2	3	4	5

Could you give me an example to explain why do you say so?

1.2 How often do <u>you</u> practice <i>identifying what adds value for internal and external clients?</i>	Rarely		Often		All the time
	1	2	3	4	5

Could you give me an example to explain why do you say so?

Figure 4.2 - Excerpt of the form adopted for assessing LLCs

Step 3 is concerned with the identification of the CFs that influence the LLCs. Data from the system characterisation carried out in Step 1, as well as a list of 51 CFs (Appendix A) developed from previous studies may support this step (e.g. Marodin and Saurin 2015; Shah and Ward 2003; Shah, Chandrasekaran, and Linderman 2008; Browning and Heath 2009; Camuffo and Gerli 2018; Netland 2016). The CFs might be categorised according to the previously mentioned four sub-systems of socio-technical systems. CFs that originate out of the boundaries defined in Step 1 should be considered as external, while the others are internal.

Step 4 is concerned with the analysis of evolution over time of those CFs identified in step 3. It is suggested following up the changes in the CFs in a one-month interval, on average. This step is important since changes in CFs may trigger the need for using the LLCs.

Step 5 refers to the identification of leadership events, defined as the evolving micro systems in which CFs and LLCs interact with each other in a practical and observable way. Leadership events may last from hours to weeks or months, have a trigger representing their start (this might be a change in CFs), and an output that can be a decision, an instruction, a document, or a physical change, such as a new layout or even a new factory.

In **Step 6**, an analysis of the interactions between CFs and LLCs is carried out by means of causal-loop-diagram (CLD). These diagrams are useful to understand interactions in complex

systems (Kirkwood 1998), and they enable a holistic analysis of leadership events, accounting for a broad set of interactions. In principle, a conceptual CLD may be developed in order to account for all possible logical interactions between LLCs and CFs. However, specific CLDs may also be developed for each leadership event identified in Step 5. These CLDs may be more meaningful and easier to understand.

Lastly, **Step 7** starts with the proposition of practical recommendations to cope with the CFs. These recommendations could be focused on: (i) CFs that are either clearly supportive or hindrances to LLCs; and (ii) CFs that could be intentionally influenced by the company to some extent. This step also involves the assessment of the impact of the recommendations on the LLCs, through a path analysis. A path is a sequence of variables that connects the cause to the effect variables (Montibeller and Belton 2006). Based on the CLDs developed in Step 6, the path analysis allows for investigating how a change in a causal factor (i.e. the recommendations) propagates to an effect variable (i.e. the LLCs). The relative impact on the effect variable depends on the total polarity of the path (Schoenenberger et al. 2016) which is calculated by multiplying the path's individual link polarities. A positive polarity path means that if the cause variable increases, so does the effect variable.

4.3.3. Instantiation of the method

4.3.3.1. Data collection

Data collection for applying the method was carried out mainly by the first author of this paper, over 7 months. Table 4.2 lists the data collection techniques and the method steps for which the data were useful.

Table 4.2 - Data collection techniques and their association with the method steps

Sources of data	Method steps							Total
	1	2	3	4	5	6	7	
Literature review			X					-
Interviews	X	X	X	X	X	X	X	10 interviews, 15 hours
Questionnaires		X	X	X	X	X		11 respondents
Non-participant observation	X	X	X	X	X	X	X	6h
Documents	X	X	X	X	X	X	X	-

Notes: numbers correspond to those steps presented in Figure 4.1

Table 4.3 presents the types of leaders who participated in data collection involving interviews and questionnaires. They represent all hierarchical levels, from the shop floor to top management.

Table 4.3 - Types of leaders who participated in this study

Leaders who participated in this study	Main role	Number of followers (on average)
1 Plant manager	General management of the site. Reports results to corporate office.	6
2 Managers (Lean, Logistics, Quality, Production, HR, Safety, Engineering, and Maintenance)	Support lean implementation within their specialty areas, across the whole plant. Report results of their areas to the plant manager	6
3 Group Leaders (both in production and other areas)	Support lean implementation in departments, comprised of several cells. Report results of their areas to their managers	3
4 Team leaders (only in production)	Support lean implementation within cells. Report results of their team to their group leaders	3

As for the **interviews**, they included: (i) three interviews with managers to assess CFs, (ii) six follow-up interviews with the lean manager focusing on the description of the context dynamics, and (iii) an interview through the Critical Decision Method (CDM) with the lean manager. The three managers interviewed were the lean manager, the HR manager, and the logistics manager. The lean manager was the main staff member involved with LP and he recommended that the other two managers should also be interviewed due to their day-to-day active participation in the lean system. These interviews followed a script divided in three sections: (i) description of the interviewee's role and responsibilities; (ii) description of the status of lean in their area; and (iii) CFs that influenced their activities. Each interview lasted approximately 1.5 hours, was audio recorded, transcribed and subjected to content analysis. The follow-up interviews were based on the description of the changes between two sequential follow-ups. These interviews did not follow a structured script and they started from the question 'What changes have occurred in the site since our last interview?' The interval between each follow-up was 36 days on average.

An interview based on the Critical Decision Method (CDM), with the lean manager, also contributed for the data collection. CDM is a technique for knowledge elicitation which emphasises cognitive aspects, like decision-making and planning, and it focuses on past events (Crandall, Klein, and Hoffman 2006). CDM interviews have four stages, according to Crandall, Klein, and Hoffman (2006): i) identification of a challenging event experienced by the interviewee; ii) development of a timeline; iii) deepening, and iv) ‘what if’ queries. The CDM interview lasted 2.5 hours, and it supported the elicitation of decision-making to cope with the contextual changes.

Regarding **questionnaires**, one form was developed to assess leadership competencies based on the list of competencies identified by (Seidel et al. 2017). Fourteen associates (7% of total) distributed along four hierarchical levels participated in this assessment. Of this total, eleven are leaders (47% of total of leaders): three managers (n=3), seven group leaders, analysts and supervisors (n=7), and one team leader (n=1). Additionally, three operators assessed their leaders (n=4). The assessed leaders have 15.4 years of experience as leaders, on average, and 12.7 years of experience in the company, on average. All participants answered the questionnaire during their working hours, a fact that restricted the number of respondents, mainly the team leaders and managers.

Non-participant observations focused on leaders’ routine activities associated with LP, such as the Key Performance Indicators (KPI), and audits. The **analysis of documents** offered insights into several method steps. It involved records of current process improvement initiatives, like value stream maps, action plans, training materials, and procedures. The **literature review** played a role as a source of CFs to be considered in the site’s assessment.

4.3.3.2. *Data analysis*

A content analysis was carried out by identifying excerpts of text from notes of observations, transcripts of interviews, and documents. Thus, when analyzing data, researchers looked for excerpts of raw textual data that could support the identification of information related to the seven data analysis categories mentioned in Table 4.4. All codifications made by the first author of this study were thoroughly reviewed by a peer researcher as to generate the results presented in this paper. Descriptive statistics, such as means and standard deviations, were used for

analysing data from the questionnaires, which produced information that was directly used in steps 5 and 6.

Table 4.4 - Categories of qualitative data analysis

Categories of data analysis	Information that was searched in the sources of data	Steps of the method
Characteristics of the socio-technical system	Characteristics of the sub-systems of the socio-technical system: technical, social, work organisation, and external environment	Delimitation of the system boundaries (step 1) and CFs assessment (step 3)
Lean leadership competencies	Leadership behaviours or actions that can be matched with the LLCs list	LLCs assessment (step 2)
Contextual factors	Characteristics of the workplace that can be matched with the CFs list from the literature review	CFs assessment (step 3)
CFs evolution over time	Changes in the CFs over time	Analysis of CFs evolution over time (step 4)
Leadership events	Events where several CFs interacted and changed, triggering the need for LLCs	Identification of leadership events (step 5)
Interactions between CFs and LLC	Identification of interactions between the CFs and LLCs	Analysis of interactions between CFs and LLCs (step 6)
Recommendations to cope with CFs	Recommendations to cope with threats and opportunities related to the context, which could affect LLCs	Practical recommendations and their assessment (step 7)

4.4. RESULTS

In this section, the results of applying steps 1 to 7 of the method are presented.

4.4.1. Step 1: Delimitation of boundaries and description of the system's main characteristics

As previously mentioned (Section 3.1), the studied system is the plant of a manufacturer of automotive components located in the United States. The company is based in Mexico with operations and technology centres worldwide. It is a tier 1 manufacturer, with more than 10,000 employees.

The lean journey started in 2010 based on problem solving initiatives using the A3 technique. In 2013, a lean corporate office was created with fully dedicated personnel. In parallel, seven

workshops were developed with the assistance of external consultants, all of which were ex-Toyota leaders. Each workshop comprehended core lean concepts and practices, and the attendance of the plant directors and key plant leaders was mandatory. In addition to this, a lean certification programme was developed in partnership with an American university, over 3 months, which were again mandatory for all company's directors and managers. Each site has its own lean roadmap that is followed up and audited by the corporate office. This office also provides support for the sites when requested.

During the period of this study, not the whole plant was formally committed to the implementation of the lean system – some areas would be focused on future stages of the internal lean roadmap. Thus, the functional areas considered in this study were only those committed to lean, namely: production, quality, engineering, maintenance, safety, HR, and logistics. Other areas, like finance, purchasing, and sales were only considered in terms of their interactions with the areas committed to lean, and thus there was no investigation into their internal activities. Interactions with the lean corporate office were also accounted for.

Table 4.5 provides more details on the characterisation of the studied system, according to the four socio-technical subsystems proposed by Hendrick and Kleiner (2001).

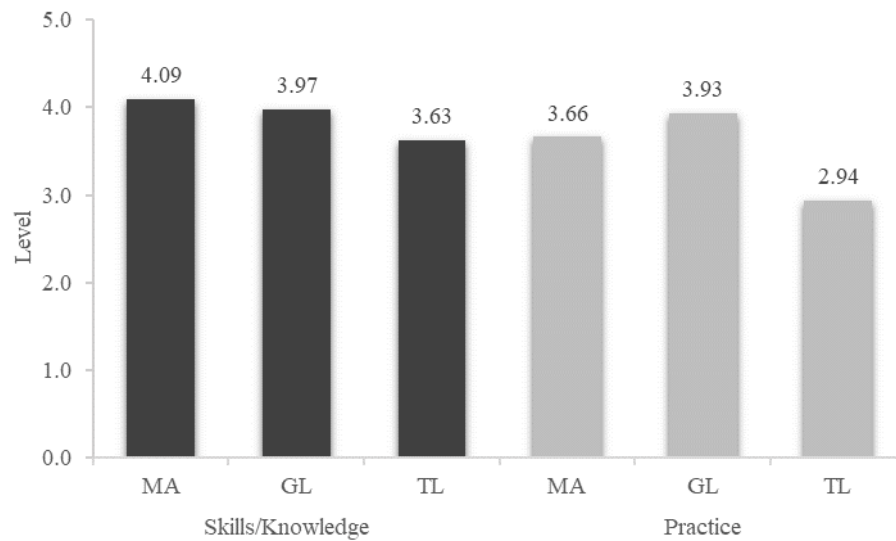
Table 4.5 - Main characteristics of the studied system

Sub-system	Characteristics	Description
Work organisation	Lean Journey	Lean is a corporate strategy which has a plan of implementation and is continuously followed up by corporate office. There is a lean manager in charge of activities coordination.
	Capacity	There was an excess of production capacity during the period of this study
	Management system	Management system is based on visual boards, visual controls, fast response teams, and daily accountability
	Layout	Layout is functional, partially as a result of the high mix and large size of the produced parts. Parts are moved by conveyors.
	Functional areas	Seven main functional areas: production, HR, logistics, engineering, maintenance, quality, and safety.

	Organisational chart	The organisational structure is flat, with three hierarchical levels between the plant manager and the machine operators. Plant Manager is the main executive in the site. He reports results to corporate office.
	Number of employees	There are 194 workers currently in the site. 146 hourly-based and 48 salary.
	Number of shifts	The site runs in two shifts
	Team size	Team size is small, up to 6 people
Technical	Machines, automation, and performance control	Large machines. Process is highly automatised and involves cutting, bending, heat treatment, painting, and assembly. Performance and quality are controlled in real time by an automatised control system
	Product complexity	Large parts, fully customised
	Process control	Highly automatised
	IT Support	Performance reports are available from the computerised control system
Social	Workforce experience	Workers are highly experienced
	Academic degree	100% has a high school degree
External	Competitiveness	Market is highly competitive
	Demand	Demand is seasonal
	Country economic status	Country economy is rising, which creates difficulties for hiring qualified workers

4.4.2. Step 2: LLCs assessment

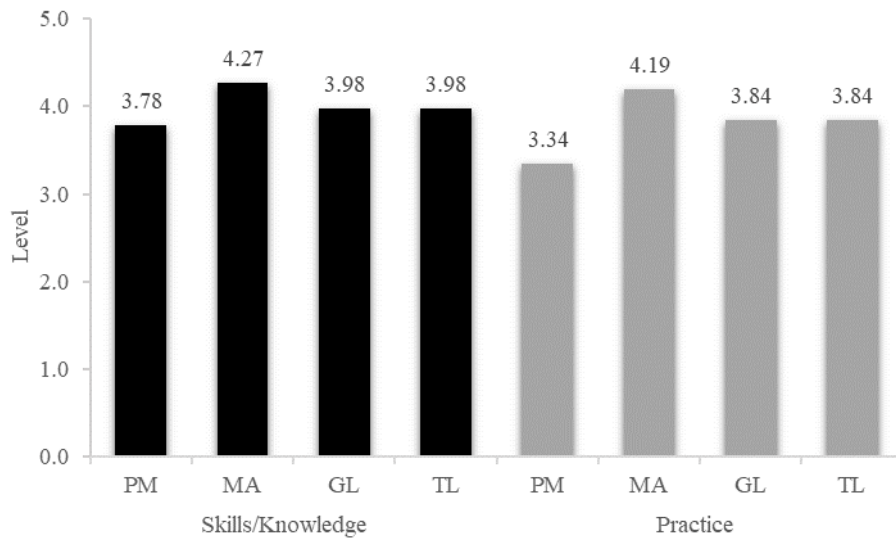
Figures 4.3 and 4.4 present the results of lean leadership competencies assessment. Regarding personal preparation to apply the competencies (e.g. skills and knowledge), the results suggest that there is significant room for improvement, given that only two out of the seven average scores were above 4.0 (i.e. 4.09 for managers' self-assessment and 4.27 for managers when leaders were assessed by their followers).



Notes: (a) MA (Managers); GL (Group Leaders, Supervisors, and Analysts); TL (Team Leaders). b) The plant manager (PM) did not carry out his self-assessment

Figure 4.3 - Self assessment of LLCs

Concerning the level of practice (e.g. the behaviours observed), only one out of the seven average scores was higher than 4.0, and again for MA, as assessed by their followers in this case. The interviews and observations provided additional pieces of evidence to support the finding that LLCs seem to be better developed. For instance, a GL described his leader practice of C2 - Identify and solve problems with their teams using the PDCA principle (coaching); as *'he allows groups to try their ideas and then gives feedback if needed'*. Another GL, regarding the practice of C8 (Provide value-added information clearly and objectively), described his leaders' practice as *'he understands the importance of implementing visual boards and how they can help to guide the teams in data driven decisions'*.



Note: PM (Plant Manager); MA (Managers); GL (Group Leaders, Supervisors, and Analysts); TL (Team Leaders).

Figure 4.4 - LLCs of leaders as assessed by their followers

Furthermore, Figure 4.3 indicates that the self-assessments related to personal preparation usually received higher scores in comparison with practice. The highest gap refers to the MA, which suggests that the more capable they are, the more aware of their limitations they become. A report by a GL (about his own leader) illustrates that the said gap is also perceived by followers: *‘he has the appropriate preparation to go and see the problems with their own eyes’* although *‘he sometimes relies on reports and my on-scene observations’*.

However, when analysing the scores of individual competencies, it is possible to observe some salient weaknesses. For example, C12 (Identify and manage barriers during lean production journey) and C16 (Develop innovative and challenging actions) had the lowest self-assessment scores in terms of personal preparation to apply the competencies (3.3). A GL reported that *‘being too busy it is difficult to develop new things’*, and a MA stated that *‘I would like to develop more in this area’*. Also, the results of C10 (Develop and implement guidelines, plans and policies aiming at people's development) for self-assessment and assessment of leaders by their followers (2.9 and 3.0 respectively) should be a concern for the company, since people development is critical for LP.

4.4.3. Step 3: Identification of CFs

Table 4.6 presents the CFs that impact on leadership in the studied plant, as well as their association with the subsystems of a socio-technical system. Similar to Marodin and Saurin (2015), lean manufacturing is interpreted as a dimension of the work organisation subsystem. From the 30 CFs, 17 (57%) were associated with the work organisation/lean journey, 6 (20%) with the social system, 6 (20%) with the external environment, and 1 (3%) with the technical system. The high frequency of factors related to work organisation/lean journey is positive, since these tend to be relatively more controllable than factors linked to the social and external environment sub-systems.

Table 4.6 - Contextual factors that influence on the LLCs

#	Contextual factor	Category	Description	Why is it relevant to leadership?
1	Number of employees on the plant (total)	Social	There are 194 workers currently in the site. 146 hourly (75%), 48 salary (25%), 0 (0%) contractual.	High automatisation level requiring fewer machine workers and more broadly qualified ones.
2	Distribution of academic degree	Social	100% of workers has a high school degree.	Qualified workers may be more open to the use of systematic problem-solving tools, making it easier their coaching by leaders.
3	Average workforce experience	Social	Workers have many years of experience in the company (8 years, in average).	Workers are experienced with years in the company. It may cause resistance to change.
4	Training	Social	Leaders have a tool for assessing the workers' demands for training. A lean certificate is mandatory for managers.	Leaders competencies to support lean initiatives require continuous development by training and education.
5	Level of contractual workers	Social	A limit of 15% of contractual workers is allowed according to collective bargaining, although the current number is zero due to the lower demand.	Participation of contractual workers on lean efforts require different approaches compared to others.
6	Unionisation	Social	100% of workers are unionised.	Leaders must be capable of negotiating improvements with unions, and these set constraints for which and how changes can be made.
7	Number of shifts	Work organisation	The site is running 2 shifts.	Leadership should have a consistent behaviour across shifts, and this also creates the need for effective communication among leaders and followers in handovers.

8	Quality of performance measurement system	Work organisation	There are Key Performance Indicators (KPIs) monitored on a daily basis.	They moderate the behaviours of the leaders.
9	Functional organisational structure	Work organisation	There are seven main functional areas in the site: production, engineering, HR, safety, maintenance, logistics, and quality.	Support areas have strong relationship with production and its leaders and workers. Teamwork is essential.
10	IT support for daily management	Technical	IT tends to facilitate many management routines.	Data collection is critical for the management. For the most part, data collection is automated and delivers management reports that support the analysis. The system design, considering also the quality measurements in real time, facilitates management.
11	Low level of participation of workers and staff in process improvement	Lean Journey	Level of participation is based on daily meetings and problem solvings performed. Realisation of kaizen events are not a practice.	Participation of workers and staff is critical for development of improvements.
12	Problem solving process	Lean Journey	Problem solving is a major capability required in the site although its application is not standardised in the areas.	The management system brings up the problems and the solving problems competence is crucial for everyone.
13	Quality of visual management	Lean Journey	It is in continuous improvement with implementation of new techniques. There are andon screens where stoppages must be reported.	Visual management is part of the management system (e.g. boards and andons).
14	Extent of lean implementation in the plant (not only in production)	Lean Journey	Company's operation system considers maintenance, logistics, safety, engineering, and quality.	All topics are considered in the management system.

15	Quality of lean implementation process	Lean Journey	There is an organisational method that points the actions. The site has a value stream map (VSM) where all improvements are pointed for the year.	The method is managed by the corporate office.
16	Lean implementation maturity level	Lean Journey	The system is constantly questioned and audited by lean corporate office.	The site if followed up by the corporate office.
17	Financial support for implementation	Lean Journey	Company supports lean efforts financially.	There is a budget for supporting lean initiatives.
18	Top management support	Lean Journey	Top manager has daily routines regarding lean implementaion.	Lean corporate office demands top management support for lean efforts in the site.
19	Support from corporate office	Lean Journey	Corporate office supports the lean efforts.	Lean corporate office follows up the method of implementation and its results.
20	Consultancy Support	Lean Journey	Performed by former Toyota leaders. The consultancy activities are managed by the corporate office.	It is a long-time practice of former Toyota leaders supporting lean (supported by corporate office).
21	Auditing routines	Lean Journey	Performed by lean corporate office.	Corporate lean office audits the implementation and the actions developed.
22	Staff dedication to lean implementation	Lean Journey	Supporting lean efforts is a role of all managers although the level of commitment is diferent among them.	Lean manager is also the engineering manager although lean is his priority.

23	Responsibilities of lean manager	Lean Journey	Lean manager reports lean status to the plant manager and to the corporate office.	His time dedication is crucial for the improvements, design, implementation, and control.
24	Management system adherence	Lean Journey	The site is implementing lean practices according to corporate method of implementation. The method lists several practices of meetings to discuss results and problem solvings.	The management system is based on lean practices that demand leaders' specific behaviours.
25	Motivation for using lean	External	Implementation of lean is strategic for the company. There is a corporate office managing a global approach to do this.	Lean is important for the company in general and for the site in particular.
26	Seasonal demand	External	Demand is seasonal, and its pattern is well understood by management.	Demand is seasonal requiring continuous adjustments in the production system.
27	Competitive supply chain	External	The company is part of the automotive supply chain, which is very competitive.	Customer requirements and competition demand continuous improvements
28	Position in the supply chain	External	The company is tier 1 in automotive industry.	Tier 1 companies are influenced directly by automakers rules and procedures
29	Availability of qualified workers	External	Qualification of workers is crucial due to the machine technology and automation	There is a low availability of skilled workers.
30	Availability of qualified managers	External	Qualification of managers is crucial due to the management system	Replacement of managers is difficult, and it takes a long time.

4.4.4. Step 4: Analysis of CFs evolution over time

Ten CFs (33% of the total) had significant changes over the period of this study (Table 4.7), according to the follow-up interviews. An example is related to the CF ‘support from corporate office’, which provides resources and guidelines for the continuous improvement of the KPI meetings. In these meetings, which occur on a daily basis, the managers report the results, relevant issues, their actions performed on the previous day, and also the priorities for the current day. In the fifth follow-up interview, it was reported a change in the way these meetings were conducted. Before the change, managers used to focus on reporting the problems and their effects, placing little or no emphasis on the root cause analysis and actions taken to solve such problems. This was considered by the meeting participants as an improvement opportunity, and hence support from corporate office by external consultancy was requested. After the changes, the meetings had a more proactive character, which affected the leaders’ behaviours in terms of their approach to the collection, processing, and reporting of information.

Table 4.7 - Evolution of the contextual factors over time

#	Contextual factors	Follow-up interviews						
		1 (Feb, 23rd)	2 (Mar, 21st)	3 (Apr, 22nd)	4 (May, 31st)	5 (Jul, 17th)	6 (Aug, 20th)	7 (Sep, 28th)
6	Unionisation	Union negotiation. Shifts have been changed. (E1)				Union negotiation is still ongoing. Negotiation is affecting operation because some workers are participating in the negotiations. (E1)		Union negotiation ends. New contract signed. (E1)
11	Low level of participation of workers in process improvement.		Lean manager started to lead group leaders to implement improvements. (E2)	Group leaders reported motivation in implementing improvements due to the new approach. (E2)		Lean manager was promoted as a new production manager. (E2)		
15	Quality of lean implementation process	Focused on the implementation of FMDS boards (production). (E3)			All meetings are being revised in their routines and goals. (E3)	First jishuken meeting was performed with former Toyota consultant's support.		Leaders standard work for group leader being focused.
18	Top management Support	Production manager leaves the company. Plant manager takes over the position temporarily. One reason for this change is the lack of support in lean initiatives. (E2)	Quality manager is not performing his responsibilities. Lack of support in lean initiatives. (E6)	Plant manager is changed. The new plant manager has years of experience with lean in the company. Lack of support to lean is one reason for the change.	Quality technician is promoted as quality manager. (E6)	Lean manager is promoted as new production manager taking over more responsibilities. Leaders' gaps development being identified. (E2)		Plant manager is supporting the management system.

19	Support from corporate office			Corporate office checking status of implementation. Two-day visit of consultant (ex-Toyota) to support Floor Management Developmental System (FMDS) implementation. (E7)	Corporate office workshops were scheduled. Lean audit was performed by corporate office. (E7)	Consultant 3-day visit to improve KPI meeting analysis. New plant manager is supporting the lean initiatives and demanding corporate office support. (E4)	Workshop of Standardised Work was performed. Corporate office performed a training session about quality (building quality) at university.	Corporate office performed a summit in Argentina about best practices in Engineering and Production. Consultant visit to coach managers in attending KPI meeting and supporting their teams to find process gaps.
22	Staff dedication to Lean implementation	Production manager left the company. (E2)	Quality manager was removed from work. (E6)	Quality manager left the company. A technician is temporarily leading quality area. (E6)			Workshop of Material Flow was performed in two areas by the area manager.	
24	Management system adherence	Implementation of hour-by-hour boards.	Implementation of FMDS routine in a production area. Focus on abnormality board. (E3)	Daily gemba walk with plant manager and managers is implemented on the 1st shift. Discussion of meeting routines: gemba walk, KPI meeting and fast response meeting. (E3)	All meetings are being revised in their routines and goals. FMDS is implemented. (E3)	Working on work element sheet (quick detection, quick response, quick fix).		Leaders' standard work for group leaders is focused in order to support the management system.
26	Seasonal demand	Low level of demand. (E8)				Demand starts to increase. (E8)		Demand is in high level. (E8)

29	Availability of qualified workers				Availability of qualified workers is critical in several positions.	There are difficulties to recruit workers for production positions. Lack of availability of qualified workers in the area. There are temporary workers' vacancies.	There are 10 open positions for temporary workers. There are difficulties to fill out the positions.	Lack of qualified workers is affecting production, quality and maintenance. Labor market is booming.
30	Availability of qualified managers.	Production manager leaves the company. (E2)	Quality manager is removed from work. (E6)	Quality manager leaves the company. A technician is temporarily leading quality area. (E6)	Production manager recruitment is still open. (E2)	Internal recruitment for engineering manager.	Maintenance supervisor leaves the company.	New engineering manager is hired from internal recruitment.

Note: the numbers in brackets (E1, E2,...) refer to the leadership events that will be discussed in Section 4.4.

4.4.5. Step 5 - Identification of leadership events

Table 4.8 describes eight leadership events that supported the analysis of the interactions between CFs and LLCs. All of these events were triggered by changes in the CFs (see Table 4.7) and required the use of LLCs by the involved leader. The events evolved over different time scales, from one day (E5) to eight months (E1), and encompassed all types of leaders who participated in the interviews or answered the questionnaires. Furthermore, Table 4.8 suggests that these events required naturalistic decision-making from lean leaders, which is as an aspect that seems to be overlooked in lean literature. That type of decision-making occurs when people make decisions in applied settings (rather than in lab experiments), in face of uncertainty and often under time pressure, relying on tacit knowledge and intuition (Klein 2015). By contrast, lean literature usually stresses rationalistic decision-making, which assumes a structured comparison between courses of action, based on explicit data and knowledge (Klein 2015) – e.g. Lu, Yang, and Wang (2011) when discussing options for the design of pull systems. Thus, there seems to be an opportunity for a deeper investigation of the decision-making process by lean leaders.

Table 4.8 - Leadership events

#	Leadership event (leader who played the main role in the event)	Description	Why is the event relevant to lean leadership?
E1	Collective bargaining (Plant Manager)	The collective bargaining started in January and finished in September. During that period, negotiation affected operations because some workers attended the meetings. Some improvements activities were on stand-by due to the negotiations.	This event brought uncertainty regarding the implementation of the improvements and the need for their prioritisation.
E2	Replacement of production manager (Plant Manager)	Production manager was fired in February, partly due to his lack of commitment to lean. The plant manager took over the role of production manager. The position remained open for 4 months until the position was filled in.	The production manager was in charge of the implementation of lean practices in his area.
E3	Implementation of new daily routines for group leaders (Lean manager)	This set of routines is based on the use of a whiteboard with hour-by-hour performance follow-up and identification of problems. The routines were designed by a group formed by the lean manager, the group leaders and the plant manager. The group leaders validated the preliminary design with other leaders and workers. Some doubts emerged during the implementation and support from external consultancy was requested.	The use of a whiteboard with daily discussion about the results and actions taken to solve problems implied in new social interactions and problem-solving approaches, from all team members.

E4	Improvement of KPI meetings (Lean manager)	The KPI meeting routine was reviewed and improved with support from external consultancy in a one-day visit.	Improvements in the KPI meeting affect directly the behaviours of managers involved in terms of data collection, team involvement in problem solving, and effective communication.
E5	Solving quality problems (Quality manager)	The quality manager received a customer's complaint regarding a labeling issue in a delivery. This manager presented the problem to the representatives of all areas involved in the issue, which were production, quality and logistics. A root cause analysis was carried out and counter measures taken in order to solve the problem.	Problem-solving is a basis of lean.
E6	Quality manager's phase out (Plant manager)	The quality manager criticised the company and the group leaders during a meeting with group leaders. The issue was reported to the plant manager who suspended the manager temporarily for 30 days in order to investigate the case. The manager was eventually fired, and a quality technician took over the position temporarily. After facing difficulties of filling in the position, the plant manager decided to keep the technician as a manager.	The quality manager was in charge of the implementation of lean practices in his area.
E7	Corporate office lean audits (Lean manager)	The lean manager led a corporate two-day lean audit, which encompassed a review of open issues from the last audit. The audit showed that the site had little progress since the last one and defined group leaders' routines as priority.	Auditing is a practice to evaluate adherence of the activities performed to the planning.
E8	Shift hours adjustments (Group leaders)	There was a need for reviewing the shift hours and team size due to the decrease in demand. Production ran three shifts with four teams of workers assigned on shifts following a schedule. The number of shifts and teams were reduced to two, which improved communication between them and facilitated management.	The distribution of the leaders and their teams across shifts affects the quality of communication between them.

4.4.6. Step 6 - Analysis of the interactions between CFs and LLCs

In this Section, one of the leadership events is analyzed based on a causal-loop-diagram, which supports the understanding of the interactions between CFs and LLCs. Similar analysis could be developed for the other events, and the one presented here serves the purpose of illustrating the analytical approach. Event E6 (quality manager's phase out, which was led by the plant manager and lasted two months) was chosen due to its relatively lower number of interacting CFs and LLCs, which could be easier to understand. The association between each leadership event and the CFs and LLCs is presented in Appendixes B and C, respectively.

According to the causal-loop-diagram (Figure 4.5) E6 was triggered by a change in the CF 'availability of qualified managers' – i.e. this availability was temporarily reduced due to the

dismissal of the quality manager. Two LLCs deployed by the plant manager were directly affected by the change in this CF.

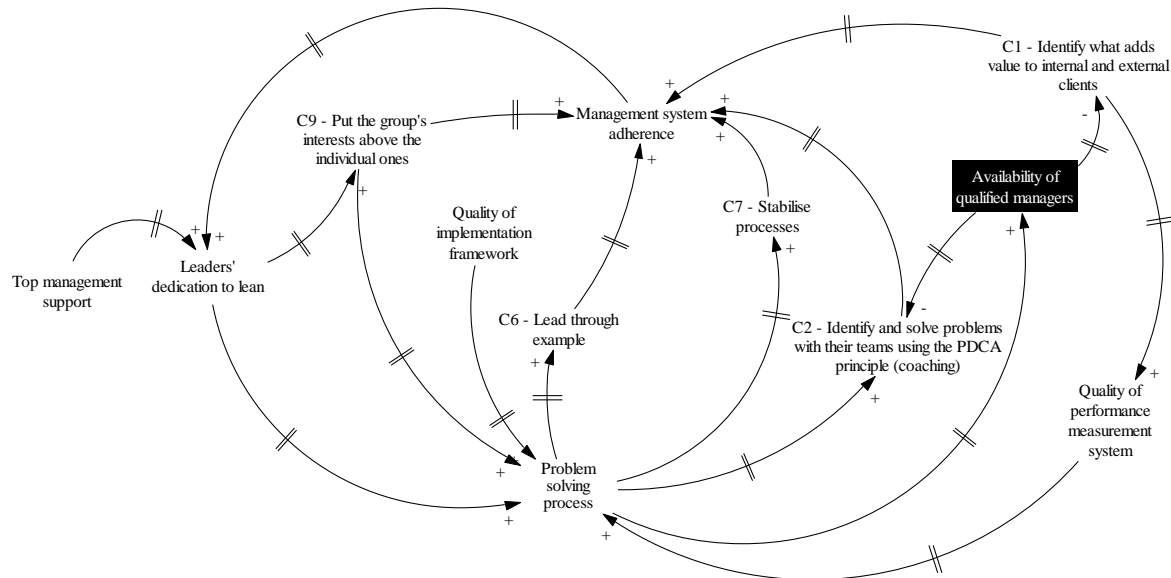


Figure 4.5 - Interactions between CFs and LLCs during quality managers' phase out (E6).
 Note: the CF 'availability of qualified managers' is highlighted since it triggered the leadership event

C1 was affected to the extent that the plant manager was demanded to assess how the dismissal of the quality manager could affect requirements of both internal and external clients. As such, a decrease in the variable 'availability of qualified manager' implied an increase of intensity of C1 by the leader – this is why the link between these variables has a negative polarity. A similar reasoning applies to the link between the CF that triggered the event and C2. The intensity of using this LLC also increased since the plant manager followed the PDCA cycle for the overall management of the event. Figure 4.5 also indicates that the use of the LLCs affected the CF 'management system adherence', which means that the use of the competencies occurred in accordance with the expectations set by the management system. In turn, this had a positive relationship with the CF 'leader's dedication to lean', that is, the time the leaders dedicate to translating the abstract lean principles into practical actions. In this specific leadership event, the leader dedication to lean implied the need for temporarily setting aside some of his other routine activities and prioritising the problem-solving of a fairly urgent operational problem (i.e. how to replace the dismissed quality manager) – this means that C9 played a role, since the leader's own individual goals were secondary in face of the group's interest. Another link worth mentioning refers to the positive relationship between the CFs 'problem solving process' and

‘availability of qualified managers’. This link suggests that the whole set of interactions ultimately feeds back onto the original CF that triggered the event, contributing to coping with it in an effective manner.

Furthermore, all relationships involve a time delay between cause and effect. This was assumed to be so due to the social and organisational nature of the variables, which differs from the simple improvement or replacement of technical parts. Although the replacement of a management position may also be framed as the substitution of a ‘part’, the social nature of this situation is assumed to involve less visible and delayed interactions in comparison with a purely technical replacement (e.g Achanga et al., 2006). An example of delay refers to the use of C1 and C2 after the dismissal of the quality manager. A technician was appointed as a temporary replacement, which allowed a window of time for the plant manager to lead the design of a permanent solution through the initial deployment of C1 and C2.

4.4.7. Step 7 – Practical recommendations and their assessment

In order to illustrate the consequences of applying the method, two practical recommendations arising from the data collection and analysis are discussed in Step 7. Table 4.9 presents the recommendations, their rationale, the path analysis, and their polarity. While the recommendations would be beneficial for the development of all LLCs, Table 4.9 illustrates their influence in the context of event E6.

Table 4.9 - Example of practical recommendations and their path analysis

#	Recommendation	Contextual factor affected by the recommendation	Rationale behind the change	Path polarity	Path (from change to effect on LLCs)
1	Implementation of a lean leadership development programme considering all hierarchical levels	Availability of qualified managers	To continuously develop lean leaders in all hierarchical levels reducing the lack of qualified leaders	-	<p>The diagram illustrates a causal loop. Two recommendations, 'Recommendation 1' and 'Recommendation 2', both point to a central node 'Availability of qualified managers'. 'Recommendation 1' has a negative polarity (-) and 'Recommendation 2' has a positive polarity (+). The central node 'Availability of qualified managers' has a positive polarity (+). From this central node, two arrows point to 'C1 - Identify what adds value to internal and external clients' (negative polarity -) and 'C2 - Identify and solve problems with their teams using the PDCA principle (coaching)' (negative polarity -). There are also feedback loops from 'C1' and 'C2' back to the central node, both with negative polarities (-).</p>
2	Implementation of managers' rotation within the site	Availability of qualified managers	To reduce the impact of not having qualified managers in certain positions	-	

Note: Recommendations were represented as new variables affecting the CF 'availability of qualified managers' which triggered E6.

The underlying assumption of the first recommendation '*implementation of a lean leadership development programme*' is that, by contributing to the availability of qualified managers internal to the company, there will be lower impacts when a manager leaves the company. The design of this programme should be based on coaching and mentoring practices, as proposed by Nakane and Hall (2002) and Spear (2004). Furthermore, leadership development should include the development of the skills required to understand the context and their interactions (Birkie and Trucco, 2016).

The second recommendation involves the '*implementation of the managers' rotation within the site*'. This also affects the CF 'availability of qualified managers' by the association between job rotation, and learning and skills acquisition (Campion, Cheraskin, and Stevens 1994).

The path analysis indicates that both recommendations have a negative relationship with C1 and C2. From the perspective of the plant manager who led event E6, the greater the availability of qualified managers, the less he would need to deploy C1 and C2 in similar situations, since a replacement could be easier to be identified among the company's existing staff. This example also points out to the possibility of overusing LLCs in face on an unfavourable context. Of course, from a broader perspective and considering other leaders, the relationships would be positive, both in the sense that C1 and C2 would be deployed more frequently and in a more effective manner.

4.5. DISCUSSION

4.5.1. Four types of leadership events

In addition to the causal-loop-diagram, the interactions can also be analysed in terms of the number of CFs and LLCs involved in each leadership event. This number can be a proxy measure of the complexity of the event, as well as of the required qualification of the involved leader. This insight sets a basis for the proposition of four types of leadership events (Figure 4.6): linear, apparently linear, apparently complex, and complex. These terms reflect the nature of the interactions in the event, based on Perrow (1999): (i) linear interactions are those in expected and familiar sequence, and those that are quite visible even if unplanned; and (ii)

complex interactions are those of unfamiliar sequences, or unplanned and unexpected sequences, and either are not visible or not immediately comprehensible.

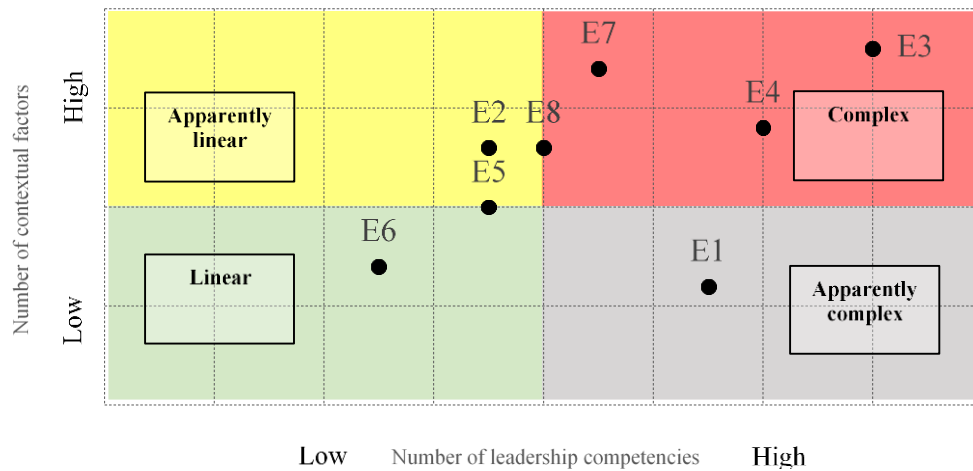


Figure 4.6 - The four types of leadership events. Notes: (E1) collective bargaining; (E2) production manager substitution; (E3) implementation of daily routines; (E4) improvement of KPI meetings; (E5) solving quality problem; (E6) quality manager’s phase out; (E7) corporate office lean audits; and (E8) shift hours adjustments

A leadership event involving a *low number* of CFs and a *low number* of LLCs is defined as **linear** by the fact that relatively few and simple interactions are likely to arise, and therefore the leader might make decisions with greater certainty of their immediate outcomes, and these decisions may strongly rely on standardised operating procedures. This situation can be illustrated by the previously discussed event ‘quality manager’s phase out’ (E6). In this case, the leader’s event had a relatively lower margin of manoeuvre, since he was constrained by the HR procedures to fill in the quality manager position. This event could have been more complex if there had been conflicting views of what should be the profile of the new professional.

A leadership event involving a *low number* of CFs and a *high number* of LLCs is defined as **apparently linear**. Although these events are ‘apparently’ linear due to the low number of CFs, these may evolve over a long timeline and be tightly-coupled with the external environment, and thus producing complex interactions that render the standardised operating procedures of little use. The event ‘collective bargaining’ (E1) illustrates this type. Although the negotiations involved in the bargaining had a clear objective, there were features that required a high number of LLCs of the leader involved, namely: (i) a lengthy process (8 months), involving a number of meetings and negotiations with many internal and external agents (e.g. the union), which

implied in different perspectives and interests to be addressed; and (ii) the relevance of the output (e.g. a collective contract), which demanded a careful consideration of the economic and technical long-term implications.

A leadership event involving a *high number* of CFs and a *low number* of LLCs is defined as ***apparently complex***. In spite of the various CFs, most of these are an integral part of day-to-day activities and thus somehow repetitive, the problem is relatively well-defined and standardised procedures can be useful for devising the solution. This type can be illustrated by the leadership event ‘solving quality problem’ (E5). In this event, a client complaint regarding the labeling of a product was discussed. In order to find out the root cause and the countermeasures, the leader (i.e. the quality manager) had to consider several CFs, such as the performance measurement (i.e. the way problems are measured), and the visual management systems (i.e. the way problems are identified and reported). Regardless of involving 10 CFs, the leader used a standardised procedure to perform the root cause analysis with the team involved in the analysis. According to the quality manager, the root cause was easily identified in the first meeting with the team members.

Leadership events involving a *high number* of CFs and a *high number* of LLCs are defined as ***complex***. In addition to the potential large number of interactions, these events tend to be complex because they may evolve over a long time, involve many diverse agents, and there may be trade-offs and uncertainty due to these characteristics. The event ‘improvement of KPI meetings’ (E4) illustrates this type. This event involved changes in the management system that impacted on the behaviours of a high number of managers and their teams, across all areas of the plant. The design of new routines had the support of an external consultant, and it involved negotiations and follow-ups until they could be considered effectively implemented, requesting a broad set of LLCs. Furthermore, in comparison with the other aforementioned examples, this event was more connected with social interactions that form the core of everyday lean implementation (Soliman, Saurin, and Anzanello, 2018), and therefore the need for using a broader set of LLCs was natural.

4.5.2. Lean leadership as an emergent phenomenon

Figure 4.6 implies a situational approach of lean leadership, suggesting that an effective leader must be able to navigate between the quadrants of the model. Effective leaders need to match their behaviour to each situation, and due to this, leadership requires continuous adjustment to local conditions in order to be sustained under a dynamic context (Snowden and Boone 2007). The demand for the continuous adjustment to local conditions can involve the use of different leadership styles (Tortorella et al. 2018) and different management practices to exert influence (Netland, Schloetzer, and Ferdows 2015; Martínez-Jurado and Moyano-Fuentes 2014).

As such, lean leadership can be framed as an emergent phenomenon arising from the dynamic interactions between the leader and their socio-technical context. Emergence is a core characteristic of complex systems and it has two main characteristics (De Wolf and Holvoet 2005): the global behaviour arises from local interactions between parts of the system (e.g. leader, followers, and lean management practices), and, the said behaviour exhibits new properties (e.g. lean leadership), which are not found in the individual parts.

This perspective of lean leadership also sheds light on how the competencies arise. Based on this research study, the proposition can be made that LLCs partially arise from self-organisation (i.e. a characteristic of complex systems) when leaders need to cope with leadership events in lean systems, and partially from intentionally designed mechanisms to support the competencies development. As for the latter, the mentoring process of the external consultant with the lean manager is an example. Furthermore, the lean management system (e.g. a CF) seems to play a key role in moderating the development of the leaders' competencies.

The proposed perspective is connected with Complexity Leadership Theory (CLT), which so far had not been linked to lean leadership in the literature. The main assumptions of CLT are consistent with our proposal, and they are as follows (Uhl-Bien, Marion, and McKelvey 2007): (i) leadership should be adaptive and it emerges from the dynamic interactions occurring within a social system, and (ii) leadership should manage the context in order to catalyze adaptive leadership and emergence. Furthermore, the Law of Requisite Variety (Ashby 1956), which is a core concept of complexity theory, postulates that the variety of a controller (e.g. a lean leader) should match the variety of the system to be controlled (e.g. a leadership event). This is aligned to the proposed situational approach of lean leadership.

4.6. CONCLUSIONS

4.6.1. Contributions of this study

The two research questions that guided this study had been stated as follows: how can the influence of context on LLCs be assessed? (RQ2) Which should be the unit of analysis for exploring the interactions between context and LLCs? The method displayed in Figure 4.1 directly addresses RQ1, by articulating several steps of data collection and analysis, under a holistic perspective. RQ 2 was addressed by the introduction of the lean leadership concept, which supports the detailed analysis of the interactions between CFs and LLCs in observable events, meaningful from a practical perspective.

This research study produced the five typical outputs of DSR mentioned in Section 3.1. A generic *method* was produced, which in principle can be applied in companies of different sectors. As for new *constructs*, two were proposed in this study: leadership events and, lean leadership as an emergent phenomenon. Leadership event is a key unit of analysis to understand the interactions between CFs and LLCs. The notion of lean leadership as an emergent phenomenon makes it clear that it cannot be fully developed through formal mechanisms, and that it requires the day-to-day exposition of leaders to a wide set of varying leadership events, which can support the development of their adaptive skills. In this sense, the *model* of lean leadership events (see Figure 4.6) highlights the need for developing the leaders' skills to assess the context, in order to match their behaviour to the situation – in fact, the model itself can be useful for leaders in this regard, by positioning the leadership event in the quadrants. Concerning the *instantiation* of the method, for the company investigated it had practical utility as a basis for the identification of opportunities for leadership development. This instantiation can also be useful for companies with similar contexts.

Regarding *theory refinement*, this study has shown how to analyse the influence of CFs on LLCs, which is a contribution of prescriptive nature. This type of contribution refers to the development of guidance about what actions will and will not lead to the desired result (Carlile and Christensen 2005). In the case of this research study, by following the steps of the proposed method, and by operationalising its main embedded constructs, it is possible to obtain insights into how lean leadership has been deployed in a certain system and which contextual factors impact on it. Also, the application of the method is a means for the generation of data for the

development of descriptive knowledge related to lean leadership. This type of contribution consists of the description, classification, and identification of relationships between constructs (Carlile and Christensen 2005). In this sense, the method allows for describing how LLCs manifest in practice.

4.6.2. Managerial implications

Two main managerial implications of this research study might be highlighted. First, the main tool developed by this study (i.e. the method for analyzing the influence of context on LLCs) may be used fully or partially by practitioners. For instance, the questionnaire for the assessment of LLCs, the list of contextual factors, and the model for analyzing leadership events could be used as relatively standalone tools according to the specific needs of practitioners. Second, the use of causal-loop-diagrams for linking the contextual factors to LLCs offers both a practical and rhetoric basis for coping with situations and events involving undesired behaviours and/or undesired outcomes. These can be traced back to a challenging context, in line with the lean notion that poorly designed processes are the key underlying cause of failure (Liker, 2004).

4.6.3. Limitations

Some limitations of this study should be stressed. First, regardless of being a generic design, the method was tested in a specific context, and therefore generalisations about its effectiveness need further applications. Second, and partially as a result of the first limitation, the model of the four types of lean leadership events should be checked against a broader set of empirical examples in different companies, which can point out refinement opportunities. Third, a complex system has a significant level of irreducible variability, which makes it philosophically impossible to capture all CFs and their interactions.

4.6.4. Future studies

Based on this study, opportunities for further research can be mentioned, such as: (i) to apply the method in different contexts, such as small and medium size plants; (ii) to incorporate additional variables into the model of leadership events, such as the expertise of the leader who copes with the event, and the degree of novelty of the CFs; (iii) to explore in depth the nature

of the decision-making process involved in the leadership events – e.g. analyzing the role played by tacit knowledge, and analyzing to which extent decision-making is compatible with lean principles; (iv) to develop practices that may support leaders in moving across the quadrants of the model of types of leadership events; (v) to follow up the results of applying the practical recommendations arising from the method application; and (vi) to carry out computer simulation of the causal-loop-diagram in order to obtain quantitative insights into the influence of the CFs on the LLCs.

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Appendix A. Literature review of contextual factors

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#	Contextual factors	Subsystem	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
1	Support of corporate office	External									x			
2	Country context and culture (i.e. instability, uncertainty)	External	x	x					x	x				x
3	Timing	External							x					
4	Company size	External											x	
5	Profitability due to LPI	External									x			
6	Annual revenue	External												x
7	Maturity level of companies in the same region	External					x				x			
8	Demand variability	External	x								x			
9	Extent - spectrum of implementation (not only in production)	Lean Journey	x			x			x					
10	Quality of implementation framework	Lean Journey	x	x							x			
11	Maturity level of implementation	Lean Journey		x			x			x	x			

12	Financial support for implementation	Lean Journey			x		
13	Top management support	Lean Journey		x			x
14	Consultancy support	Lean Journey				x	
15	Control (Auditing routines)	Lean Journey				x	
16	Average of number of workers/number of value stream managers	Lean Journey				x	
17	Staff dedication to lean	Lean Journey				x	x
18	Responsibilities of lean manager	Lean Journey		x		x	
19	Leaders' competencies	Lean Journey		x		x	
20	Communication of lean within the company	Lean Journey		x		x	
21	Time of lean journey	Lean Journey				x	x
22	Existence of control room	Lean Journey				x	
23	Impact of performance metrics	Lean Journey				x	
24	Structure to capture employees suggestions	Lean Journey				x	
25	Accounting system	Lean Journey		x			

26	Integration with other systems/philosophies	Lean Journey	x						
27	Policy focus and deployment	Lean Journey	x						
28	Quality of performance measurement system	Lean Journey	x				x		
29	Education and Training	Social	x	x	x			x	x
30	Low level of participation of workers in process improvement	Social	x					x	
31	Lean knowledge of management team	Social						x	
32	Organisation culture	Social	x						
33	Labor qualification (expertise)	Social						x	
34	Level of contractual workers	Social	x						
35	Remuneration system	Social	x						
36	Experience and age of workers	Social						x	
37	Availability of qualified workers	Social						x	
38	Job security due to improvements	Social						x	
39	Workforce educational level	Social						x	

References: (R1) Moyano-Fuentes and Sacristán-Díaz (2012); (R2) Bhamu and Singh Sangwan (2014); (R3) Jasti and Kodali (2014); (R4) Jasti and Kodali (2015); (R5) (Narayanamurthy and Gurumurthy 2016); (R6) (R. Shah, Chandrasekaran, and Linderman 2008); (R7) (Browning and Heath 2009); (R8) Netland (2016); (R9) Marodin and Saurin (2015); (R10) (Rachna Shah and Ward 2003); (R11) Marodin et al. (2016); (R12) (Guilherme Luz Tortorella et al. 2015).

Appendix B. Relationship between CFs and leadership events

#	Contextual fator	Leadership events (and its leaders)								Sum of events affected by each contextual factor
		1 Collective bargaining (Plant manager)	2 Production coordinator substitution (Plant manager)	3 Implementation of daily routines (Lean manager)	4 Improvement of KPI meetings (Lean manager)	5 Solving quality problems (Quality manager)	6 Quality managers' phase out (Plant manager)	7 Corporate office lean audits (Lean manager)	8 Shift hours adjustments (Group leaders)	
1	Number of employees on the plant (total)								X	1
2	Distribution of academic degree									0
3	Average workforce experience			X					X	2
4	Training	X		X		X				3
5	Level of contractual workers	X							X	2
6	Unionisation	X							X	2
7	Number of shifts		X	X					X	3
8	Quality of performance measurement system		X	X	X	X	X	X	X	7
9	Functional organisational structure		X	X	X	X		X	X	6
10	IT support for daily management				X	X			X	3
11	Competitive supply chain		X							1
12	Position in the supply chain		X							1

13	Low level of participation of workers and staff in process improvement			X				X	X		3
14	Problem solving process		X	X	X	X	X	X	X		6
15	Quality of visual management			X	X	X			X		4
16	Extent of lean implementation in the plant (not only in production)	X			X	X			X		4
17	Quality of implementation framework	X	X	X	X			X	X		6
18	Lean implementation maturity level		X	X	X	X			X	X	6
19	Financial support for implementation								X		1
20	Top management Support		X	X	X			X	X	X	6
21	Support from corporate office			X	X				X		3
22	Consultancy Support			X	X				X		3
23	Control (auditing routines)			X					X		2
24	Leaders' dedication to lean implementation		X	X			X		X		4
25	Responsibilities of lean manager		X	X	X				X		4
26	Management system adherence		X	X	X	X	X	X	X	X	7
27	Motivation for using lean			X	X				X	X	5
28	Seasonal demand	X								X	2

29	Availability of qualified workers									0
30	Availability of qualified managers		x					X		1
Sum of contextual factors affecting each event		6	13	18	14	10	7	17	13	

Appendix C. Relationship between LLCs and leadership events

#	Leadership event	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	Sum
1	Collective bargaining	x	x		x	x		x	x	x				x	x	x	x	11
2	Production coordinator substitution	x	x				x	x		x			x		x			7
3	Implementation of daily routines	x	x	x		x	x	x	x	x		x	x	x	x	x	x	14
4	Improvement of KPI meetings	x	x	x		x	x	x	x	x		x		x	x		x	12
5	Solving quality problems	x	x	x		x	x	x	x									7
6	Quality manager's phase out	x	x				x	x		x								5
7	Corporate office lean audits	x		x	x	x	x		x			x		x	x			9
8	Shift hours adjustments	x	x					x	x	x			x		x	x		8
	Sum	8	7	4	2	5	6	7	6	6	0	3	3	4	6	3	3	

5. CONCLUSÕES

5.1. CONTRIBUIÇÕES DA TESE

Esta tese teve como objetivo geral a proposição de um método para a análise do impacto do contexto sobre as competências de liderança *lean*. Quanto aos objetivos específicos, dois foram estabelecidos: (i) investigar sobre como as teorias gerais de liderança podem auxiliar para a expansão do conhecimento sobre a liderança *lean*; e (iii) identificar e validar as competências de liderança *lean*.

O capítulo 2 da tese respondeu ao objetivo específico (i) por meio da análise comparativa entre como a literatura sobre a liderança *lean* e sete teorias gerais de liderança abordam três constructos base das teorias de liderança: atributos pessoais, processo de influência e contexto. Para tal foram desenvolvidas proposições sobre como cada uma das teorias de liderança analisadas pode contribuir para a expansão do conhecimento sobre a liderança *lean*. Os resultados do estudo indicaram que todas as teorias analisadas podem contribuir para a liderança *lean* e que ela pode ser interpretada como uma instanciação prática das teorias em um ambiente *lean*. Os resultados também sugerem que a liderança *lean* pode assumir diferentes manifestações, dependendo do contexto ao qual ela está inserida.

O capítulo 3, por sua vez, contempla o segundo artigo da tese e teve como principal objetivo identificar e validar as competências de liderança *lean*, respondendo ao objetivo específico (ii) da tese. Assim, uma lista com dezesseis competências foi desenvolvida baseada num método de pesquisa que utilizou um conjunto de diferentes técnicas de coleta de dados. Tal abordagem metodológica, com suporte tanto teórico quanto prático, é uma característica que distingue este estudo dos anteriores sobre liderança *lean*. Os resultados do estudo apontaram para a validade das dezesseis competências identificadas. A validade foi confirmada a partir das correlações significativas e positivas encontradas entre: (i) as competências de liderança e o nível de maturidade do líder em relação ao SPE e (ii) as competências de liderança e o nível de maturidade da organização em relação ao SPE.

Por fim, o capítulo 4 atende ao objetivo geral da tese. Este capítulo teve como principal objetivo atender a questão de pesquisa “como avaliar o impacto do contexto sobre

as competências de liderança *lean*? A estratégia de pesquisa que norteou o desenvolvimento deste estudo, bem como da tese como um todo, foi o *Design Science Research* (DSR), realizado empiricamente em uma empresa manufatureira. Nesse sentido, cabe salientar que os capítulos 2 e 3 tiveram o papel de auxiliar na compreensão do principal problema tratado nessa tese (avaliar o impacto do contexto sobre as competências de liderança). De fato, o artigo 1 da tese (ver capítulo 2) evidenciou a contribuição dos três constructos de liderança para o entendimento do que se trata a liderança *lean*. Por exemplo, a análise do constructo “processo de influência” mostrou que as teorias gerais de liderança o descrevem como um resultado dos comportamentos da liderança e das interações sociais entre os líderes e os seus liderados. Esta descrição do processo de influência tem alinhamento com os princípios e práticas dos SPEs como, por exemplo, tornar os problemas visíveis com o uso da gestão visual para o engajamento dos liderados (KANE et al., 2015). O estudo também destacou algumas conexões das teorias de liderança com a liderança *lean*: (i) o líder deve desenvolver um relacionamento positivo (e.g. com confiança, respeito e empatia) com o liderado; (ii) os comportamentos visíveis e observáveis do líder são componentes fundamentais do processo de influência e (iii) é necessário que o processo de influência seja compatível com o contexto interno e externo da organização.

Este estudo produziu os cinco resultados típicos de um estudo tendo a DSR como abordagem metodológica. Um método genérico foi produzido o qual pode ser aplicado, em princípio, a empresas de diferentes setores. Em relação a novos constructos, dois foram propostos no estudo: os eventos de liderança e a liderança *lean* como fenômeno emergente. Um evento de liderança é a unidade de análise para o entendimento das interações entre os fatores de contexto e as competências de liderança. A noção de liderança *lean* como fenômeno emergente torna claro que ela não pode ser desenvolvida através de mecanismos formais e que ela requer a exposição diária do líder a um amplo conjunto de eventos de liderança, os quais podem apoiar o desenvolvimento das suas habilidades adaptativas. Neste sentido, o modelo dos quatro tipos de eventos de liderança destaca a necessidade do líder em desenvolver as suas habilidades de análise do contexto a fim de conciliar seus comportamentos à situação. Em relação à instanciação do método na companhia investigada, ela teve uma utilidade prática de servir como base para a identificação de oportunidades para o desenvolvimento das lideranças da organização. Em relação ao refinamento de teorias, este estudo evidenciou como analisar a influência dos fatores de contexto sobre as competências de liderança, o qual é uma

contribuição de natureza prescritiva. Este tipo de contribuição se refere ao desenvolvimento de direcionamento sobre quais ações devem ser feitas e quais não devem ser feitas para o alcance de um resultado desejado (CARLILE; CHRISTENSEN, 2005).

5.2. IMPLICAÇÕES GERENCIAIS

No que diz respeito às implicações gerenciais, voltadas à prática dos profissionais, este estudo fornece duas que merecem destaque. Primeiramente, a principal ferramenta desenvolvida pelo estudo (*i.e.* o método para análise da influência do contexto sobre as competências de liderança *lean*) pode ser utilizado integralmente ou parcialmente por profissionais. Por exemplo, o questionário para a avaliação das competências de liderança, a lista dos fatores de contexto e o modelo dos quatro tipos de eventos de liderança podem ser usados de forma independente de acordo com as necessidades dos profissionais. Em segundo lugar, o uso dos diagramas causais para a conexão dos fatores de contexto às competências de liderança oferece tanto uma base prática quanto teórica para lidar com situações e eventos envolvendo comportamentos indesejados e/ou resultados indesejados.

Os artigos 1 e 2 também oferecem contribuições para a prática gerencial. Por exemplo, no artigo 1, os três constructos utilizados para avaliar a liderança *lean* podem ser utilizados de forma prática por profissionais interessados na análise e desenvolvimento das lideranças em suas organizações. Já as competências de liderança *lean* identificadas no artigo 2 podem servir de base para o desenho de programas de desenvolvimento de lideranças ou para o desenvolvimento de ferramentas para a sua avaliação e o seu gerenciamento.

5.3. LIMITAÇÕES

As limitações identificadas nesta tese são: (i) embora seja um projeto genérico, o método proposto foi testado em um contexto específico e desta forma, generalizações sobre a sua efetividade necessitam de mais aplicações; (ii) o modelo dos quatro tipos de eventos de liderança pode ser verificado contra um conjunto amplo de exemplos empíricos em diferentes organizações o que pode direcionar para oportunidades de refinamento do mesmo; (iii) um sistema complexo tem um nível significativo de variabilidade irreduzível, o que torna impossível de capturar todos os fatores de contexto e suas interações; (iv) o uso

de diferentes palavras-chave geraria diferentes resultados nas buscas realizadas na tese.

5.4. PESQUISAS FUTURAS

Várias oportunidades de pesquisas futuras podem ser destacadas, tais como: (i) aplicar o método proposto em outros casos em diferentes contextos; (ii) incorporar variáveis adicionais no modelo dos quatro tipos de eventos de liderança, tal como a experiência do líder que lida com um determinado evento; (iii) desenvolver estudos que apoiam os líderes na sua movimentação entre os quadrantes do modelo dos quatro tipos de eventos de liderança; (iv) investigar as proposições sugeridas no artigo 2 em termos teóricos e práticos; (v) investigar as competências de liderança em variantes da PE, tais como *Lean Six Sigma* e *Lean Agile* e (vi) refinar a lista das competências de liderança identificadas.

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