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Meaningful inhibitors of the Lean journey: A Systematic Review and categorisation of over 20 years of literature

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Meaningful inhibitors of the Lean journey: A Systematic Review and categorisation of over 20 years of literature

Abstract:

Lean philosophy has been one of the most prominent methodologies of process improvement. Positive results from lean implementations have motivated managers to carry out lean transformations. However, the low success rates, linked to barriers to implement lean are still a challenge, and one of the reasons is the lack of understanding of these inhibitors. Scholars have investigated barriers that affect the lean journey, some of these barriers overlap and require a meaningful categorisation. Thus, the purpose of this paper is to fill in this gap by providing a review of more than 20 years of literature, and synthesising these barriers into meaningful organisational categories. To achieve this aim, we employed a systematic literature review. Our findings present six meaningful lean barriers, which we categorised into a framework. These barriers have mainly behavioural and organisational aspects (people-dependent), and technical aspects (tool-based). Finally, we derived eight propositions, contributing to knowledge and practice.

Keywords: Lean barriers; inhibitors, enablers; tool-based; people-dependent

Word count: 9381

1. Introduction

Over decades, lean philosophy has been used as a significant organisational long-term strategy for process improvements, across different industries (Karlsson and Åhlström, 1996; Bhasin and Burcher, 2006; Radnor and Walley, 2010). Initially developed by the Japanese manufacturer Toyota, as its production system in the mid-1950's, it was later termed and spread across western companies as 'lean thinking' by Womack *et al.*, (1990). The lean approach focuses on waste elimination and creation of value for the customer (Hodge *et al.*, 2011; Radnor and Osborne, 2013), and that pragmatic methodology has supported manufacturers to achieve superior results, improving the processes and adding more value for customers (Womack and Jones, 1996; Bowen and Youngdahl, 1998). From the advent of the lean concept to the present day, lean has evolved, and its techniques and principles have been adapted in services areas (Allway and Corbett, 2002; Leite and Vieira, 2015; Yadav *et al.*, 2018).

The implementation of lean in the service industry has rapidly become a standard tested and used approach, with positive results in different areas, such as public services, construction, healthcare, offices and banks (Bowen and Youngdahl, 1998; Mazzocato *et al.*, 2012; Bateman, Hines and Davidson, 2014; Tezel *et al.*, 2018). The implementation of Lean principles in service industry operations has experienced similar benefits to manufacturing implementations, including waste elimination being tackled across the processes, adding value for customers (Bowen and Youngdahl, 1998; Kim *et al.*, 2006; Radnor, 2010; Radnor and Osborne, 2013).

Regardless of the positive results from lean implementation, the challenges to implement and sustain this new approach have emerged in both the manufacturing and services sector (De Souza and Pidd, 2011; Bhasin, 2012c). In literature, several scholars have reported on the low success rates of lean implementation (Bhasin, 2013; Sisson and Elshennawy, 2015b; Dorval *et*

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3 *al.*, 2019). For instance, Jadhav *et al.*, (2014) found that two-thirds of implementations culminate
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5 in failure, and less than one-fifth of the ones implemented have sustained results. Some scholars
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7 have found lower success rates; for example, Bhasin and Burcher (2006) reported that less than
8
9 ten per cent of companies succeed in implementing or sustaining the lean philosophy. Services
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11 and manufacturing organisations have encountered difficulties in sustaining the lean journey.
12
13 Bhasin (2012a) and DeSanctis *et al.*(2018) advocate that the lack of ability to cope with barriers,
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15 faced in the implementation and sustainability process, is one of the main reasons for this low
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17 success rate.
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22 Literature identifies lean barriers across different areas, such as manufacturing (Bhasin,
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24 2012a; Yadav and Desai, 2017) healthcare systems (De Souza and Pidd, 2011), IT services
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26 (Kundu and Manohar, 2012), public services (Radnor *et al.*, 2006), and SMEs (Hu *et al.*, 2015).
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28 In literature, there are extensive examples of inhibitors that constrain the lean implementation,
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30 for instance the lack of resources (financial, time and human resources) (DeSanctis *et al.*, 2018;
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32 Bateman and Rich, 2003; Vienažindienė and Čiarnienė, 2013); lack of knowledge and
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34 understanding of the lean approach (Karlsson and Åhlström, 1996; De Oliveira *et al.*, 2018;
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36 Caldera *et al.*, 2019); leadership issues (Hacker and Doolen, 2005; Kim *et al.*, 2006; Yadav *et al.*,
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38 2019); lack of organisational strategy (Albliwi *et al.*, 2014; Poksinska, 2010; Sreedharan *et al.*,
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40 2018); resistance to change (Jadhav *et al.*, 2014; Salem *et al.*, 2016; Madsen *et al.*, 2017); and
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42 cultural hurdles (Bhasin, 2011, 2012; Timmons *et al.*, 2014; Muraliraj *et al.*, 2018).
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47 These barriers are drawn from different settings and countries. For example, Dora *et al.*,
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49 (2016) investigated the impact of contextual barriers on lean manufacturing in SMEs operating
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51 in food-processing industries in Belgium. Another example, is the impact of leadership during
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53 the lean journey in Brazil, which was reported by Tortorella *et al.* (2018); in the UK, a study
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3 conducted by Bhasin (2013) reported several barriers that constrain lean in British manufacturing
4 companies. There are other examples in developed countries, such as USA, Canada, Australia
5 and Germany (Kumar, 2014; Fournier and Jobin, 2018; Kregel and Coners, 2018; Caldera *et al.*,
6 2019); similarly, barriers were found in developing countries, for example in China, Uganda,
7 India and Kuwait (Alinaitwe, 2009; Al-Najem *et al.*, 2013; Jasti and Kodali, 2016; Gao and Gurd,
8 2019).

9
10 All the studies mentioned have contributed significantly, bringing new knowledge to
11 academics and practitioners. However, after decades, the outcome of these research studies is
12 merely a reporting of large lists of lean barriers (Poksinska, 2010; De Souza and Pidd, 2011;
13 Hilton and Sohal, 2012; Aij *et al.*, 2013a; Mostafa *et al.*, 2013; Escuder *et al.*, 2018). These lists
14 present some degree of saturation with similar barriers, many of which have considerable
15 overlaps, and barely represent new barriers. This paper aims to present a framework which
16 categorises and consolidates these barriers to provide a focused meaning for each barrier, and
17 their impact within the lean journey in organisations.

18
19 Literature indicates that the categorisation of barriers is still a challenge, and only a few
20 studies have provided insights into a classification of barriers, with most of these studies
21 providing research only in specific areas, for example leadership, green lean six sigma, technical
22 elements, or just in time (Nordin *et al.*, 2012; Jadhav *et al.*, 2015; Kumar *et al.*, 2016; Cherrafi
23 *et al.*, 2017; Tortorella and Fogliatto, 2017; Zhang *et al.*, 2017; Yadav, *et al.*, 2018). Consequently,
24 our study differs from previous studies for the following reasons, we do not aim to address
25 exclusively lean history and create a timeline of its evolution, because we understand that there
26 are relevant studies already published that cover this subject broadly (Rachna and Peter, 2003;
27 Bhamu and Sangwan, 2014; Pettersen, 2009); we aim to narrow the focus and review 20 years of

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3 literature specifically related to lean inhibitors; our study is not limited to present a list of barriers
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5 in specific areas such as healthcare, services and manufacturing, but give a broader investigation
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7 across industry sectors; finally we aim to categorise these barriers into meaningful themes based
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9 on thematic analysis (Tranfield *et al.*, 2003).
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12 To summarise, our study aims to systematically review, classify and synthesize the
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14 barriers that constrain the lean journey into specific organisational categories. Moreover, this
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16 categorisation of barriers aims to provide a framework that illustrates their interplay and impact
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18 on organisations, contributing to knowledge and practice. From these aims, we derived four
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20 research questions (RQs) that will guide our systematic literature review:
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- 23 • RQ1: What is the current outline of lean barriers in literature?
- 24 • RQ2: What are the meaningful barriers that constrain lean implementation and
25 sustainability?
- 26 • RQ3: How can lean barriers be categorised into an organisational framework?
- 27 • RQ4: What is the impact and interplay between lean barriers?
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35 In order to achieve the aims of this research and answer the RQs, the paper is organised
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37 as follows: this first section introduces the context, benefits and barriers of lean philosophy,
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39 narrowing the focus to expound the research problem, justification and purpose. The next section
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41 discusses the methodological procedures based on a comprehensive systematic literature review.
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43 The section thereafter presents the research findings. The discussion section sets out propositions
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45 based on findings and literature. Finally, the conclusion summarises the research study,
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47 presenting the answers to the RQs, contributions and an overview of our study.
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2. Methodology

This section presents the methodological procedures used to collect and analyse secondary data from academic papers. Two different methodologies were used; the primary methodology used was a systematic literature review (Tranfield *et al.*, 2003) and, secondly, a thematic analysis was applied to find common themes and explain the data (Braun and Clarke, 2006).

A systematic literature review is a common approach to access secondary qualitative data in the literature. Several academics set out guidelines on how to carry out an effective systematic literature review (Tranfield *et al.*, 2003; Cronin *et al.*, 2008; Westby *et al.*, 2008). Such reviews are encouraged by scholars that have carried out research on lean (Brandao de Souza, 2009; Mazzocato *et al.*, 2010; Hu *et al.*, 2015; Yadav and Desai, 2017). The use of a structured protocol provides trustworthiness and reliability to the study. It is a meticulous procedure with details of the searching protocol providing the opportunity for future replications of the search (Tranfield *et al.*, 2003; Bell *et al.*, 2018). The main elements of a protocol are the definition of inclusion and exclusion criteria, the selection of peer-reviewed journals from specific databases, the definition of key words and search period, as well as the saturation of the search.

In order to access rich secondary data from literature, we explored the inclusive criteria, only conducting our search in trade and academic peer-reviewed journals in several databases including, Science Direct, Emerald Fulltext, Springer Link, Taylor and Francis Online, Ebsco, Medline, PubMed and Inderscience. There were three exceptions to the peer-reviewed journals, the Lean Enterprise Institute – New Survey, Manufacturers & Exporters - Management Issues Survey and Deloitte & Touche - Lean Manufacturing Survey Report. They were selected due to their technical and practitioner nature related to Lean. The use of non-academic articles focused on lean practitioners is supported by other scholars (Conn *et al.*, 2003; Hopewell *et al.*, 2007).

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3 When carrying out a systematic literature review on lean product development, Salgado and
4 Dekkers (2018) advocate that the consideration of non-academic literature or ‘grey literature’,
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6 provides invaluable information to the field.
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10 The period of the publications considered was based on the availability of papers up to
11 the end of the 1st quarter of 2019 with the first paper found dated from 1996 (Karlsson and
12 Åhlström, 1996). The search considered over 20 years of publications related to lean barriers.
13
14 Finally, the inclusive search criteria encompassed the key words: ‘lean barriers’, ‘lean
15 challenges’, ‘lean constraints’, ‘lean inhibitors’ and ‘lean failure’, and considered the fields of
16 title, abstract and key words. The predetermination of key words chosen to search databases,
17 during the systematic literature review, supports the purpose of our study, and is also encouraged
18 by scholars that have undertaken similar studies (Brandao de Souza, 2009; Robson, 2011).
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28 The main exclusion criteria considered only papers written in English and papers that
29 address lean in operations or in production management, as some papers use the term ‘lean’ in
30 medical research. It is possible that one might find all these details and information
31 overwhelming, as they take into consideration every part of the procedure of the research
32 protocol. Therefore, in order to help an audience better understand our protocol, we created a
33 literature review framework that makes our approach more visual and describes the steps taken.
34
35 This is common practice among scholars that carry out this type of research (Hu *et al.*, 2015;
36 Salgado and Dekkers, 2018; Sweeney *et al.*, 2019) and is based on the criteria displayed in
37 Figure 1, which aims to identify and select suitable papers.
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9 The screening process was then carried out in two phases. The first screening phase considered
10 papers that presented the key words from the inclusion criteria in at least one of the fields of title,
11 abstract or keywords. This screening led to the acquisition of 346 papers that presented some
12 relation to the selection criteria. In the second screening phase, the researchers carried out an in-
13 depth and meticulous analysis of the abstract and body of these papers, checking their eligibility
14 based on the exclusion criteria, in order to find if they could contribute in any way to the purpose
15 of this study. The results of this further analysis excluded 142 articles leaving 204 papers for in-
16 depth analysis in our study. Moreover, a database was created using an Excel spreadsheet to
17 extract information that included the authors' name, year of publication, purpose of the paper,
18 methodology applied, main barriers found, and the main contribution of the paper. A similar
19 approach, when carrying out systematic literature review, is suggested by Tranfield *et al.* (2003)
20 and Sweeney *et al.* (2019).
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36 The analysis and reporting of this data followed the suggestions made by Tranfield *et al.*
37 (2003) that separate this process into descriptive analysis and thematic analysis (Braun and
38 Clarke, 2006; Hu *et al.*, 2015). The descriptive analysis presents an overview of the findings in
39 literature. A set of categories representing the distribution and allocation of literature during the
40 years of publication. For instance, it can describe geographical elements, type of research
41 approach, and common areas of application (Tranfield *et al.*, 2003).
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50 The thematic analysis is one of the most common methods in the qualitative field and
51 allows the researcher to code and keep track of the data. Moreover, it provides a level of
52 sensitivity to the details and context, ensuring accurate access to information (Braun and Clarke,
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2006; Radnor and O'Mahoney, 2013). In the thematic analysis, the data is first inducted into meaningful codes. In our research, the codes will be represented by inhibitors found in the literature researched. Thereafter, these codes will be merged into meaningful themes that appear as the main barriers and are based on repetition. These themes are supported by extracts from texts (Radnor, 2002; Braun and Clarke, 2006). For instance, several inhibitors might emerge, such as lack of financial resources, budget constraints, lack of investment and human resource constraints. These inhibitors will be labelled as codes, and later clustered around the main theme, which is the main barrier related to resource constraints.

The linking of codes into themes across different contributions, in literature and to report on the findings, is an important part of the research process. It is essential to assert that the results are deemed trustworthy, and to later enable the recommendation of a reliable approach (Patton, 1990; Tranfield *et al.*, 2003; Saunders *et al.*, 2012). Through the use of data from extraction forms, we provided the main findings from our research based on the descriptive and thematic analysis. The following section of this paper addresses the findings of our research based on the descriptive and thematic analysis performed.

3. Findings from the Descriptive and Thematic Analysis

In this section, we present the data gathered on the extraction form, presenting firstly an overview of the findings from literature using descriptive analysis. Subsequently, we aim to present the data analysis based on thematic analysis.

3.1 Descriptive Analysis

The descriptive analysis synthesizes the findings of our research; it provides an outline of the current state of publications related to lean barriers. The analysis considered relevant information

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3 from the papers researched, for example, geographic distribution of the publications, different
4 methodological approaches undertaken, and type of industry sectors. This is a categorisation of
5 the rich data found in literature, and it provides significant information for further discussion in
6 line with our RQ1.
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12 Figure 2 depicts the geographic distribution of the papers found in literature, and provides
13 information about regions in which the studies have been conducted. During the phase of data
14 collection, several countries were identified, some of them with high repetition and others with
15 low repetition. Therefore, in order to make the visual representation of the chart easier to
16 understand, we decided to organise them into their geographic regions.
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30 In the Scandinavian region, Denmark, Norway and Sweden were found. For Europe, the
31 countries that emerged during the data collection were Netherlands, Belgium, Germany, Hungary,
32 Italy, the Netherlands, Switzerland and the United Kingdom. In Africa, the only research found
33 was in Uganda and, in the Middle East region, research was found in Kuwait, Lebanon, Qatar
34 and Saudi Arabia. For Asia, research was found in China, India, Indonesia, Malaysia, Thailand
35 and Sri Lanka. In Oceania, research was carried out in Australia and New Zealand. Finally, in the
36 Americas region, research was reported in Brazil, Canada, Mexico, United States and Uruguay.
37
38 Moreover, two categories were created for papers that do not fall into any of these regions. First,
39 a category named 'not informed' (NI) for studies that do not provide their location; second, a
40 category named 'literature review'. These are literature review papers that are not focused on a
41 specific region or country, but rather have a wide coverage.
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3 Thus, considering the papers in which the geographic location was informed, the results
4 show that research on lean barriers are concentrated in three regions. Europe is providing
5 research on lean barriers occupying 18% of the papers (e.g. Bateman and Rich, 2003; Radnor *et*
6 *al.*, 2006; Bhasin, 2013a; Hadid *et al.*, 2016), followed by the Americas and Asia, with 14% each
7 (e.g. Sim and Rogers, 2008; Pingyu and Yu, 2010; Balzer *et al.*, 2015; Costa *et al.*, 2017;
8 Marodin and Saurin, 2015; Kumar and Kumar, 2015). Other regions such as Scandinavia, the
9 Middle East, Oceania and Africa, have a smaller participation in terms of volume of research
10 conducted, and together account for 9% of the publications (e.g. Alinaitwe, 2009; Maalouf and
11 Gammelgaard, 2016; Aoun *et al.*, 2018; Hihnala *et al.*, 2018; Caldera *et al.*, 2019).

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24 The research methods carried out when investigating the barriers that affect the lean
25 journey were identified and presented in Figure 3. The methods found were action research, case
26 study, focus group, literature review, mixed methods and survey. When listing these categories
27 of research methods from the literature searched, we aimed to provide a standard and comparable
28 list of research methodologies. However, some studies do not present identical nomenclatures for
29 their research methods, even though they use the same methodology. Then, when gathering and
30 analysing the data we aimed to keep related methods together. For instance, some of the authors
31 describe their method as a descriptive survey questionnaire, an electronic survey, a questionnaire
32 and a structured questionnaire. In this case we created a standardized category named 'survey'. A
33 similar situation is presented in the 'case study' category that congregates research methods
34 named as single or multi case study, in-depth case study and case method study. Furthermore, the
35 'literature review' category gathers papers that used the analysis of secondary data from
36 literature to carry out their research, such as analysis of papers, systematic literature review,
37 bibliometric analysis and literature survey.

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9 The results show that the main research methods carried out, when investigating lean barriers,
10 are case study and literature review, both of which account for 30% of the frequency. For
11 instance, Stankalla *et al.*, (2018), when investigating critical factors for lean implementation in
12 small and medium-sized manufacturing enterprises, conducted a literature review considering
13 different countries. The case study method was used by Ainul Azyan, Pulakanam and Pons
14 (2017) to explore barriers to implement lean in the printing industry. The second most common
15 research method is survey accounting for 24%. As an example, this method was undertaken by
16 Bhasin (2013a) when investigating low success rates of lean implementation in British
17 manufacturing organisations. A smaller group of other methods, encompassing action research,
18 focus group and mixed methods accounts for 5% of the methods carried out in the papers
19 searched (Fernandez-Solis *et al.*, 2013; McDermott and Venditti, 2015; Lindskog *et al.*, 2016).
20 We also found papers in which the type of research method carried out was not clear which was
21 later named as 'not informed' (e.g. Barker, 1998; Boyer and Sovilla, 2003).
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39 The interest in implementing lean in different sectors has increased (Danese *et al.*, 2018).
40 The research presented in this paper focuses on specific areas, and supports scholars and
41 practitioners in their understanding of the impact of lean inhibitors in different sectors. Figure 4
42 displays the results of the research analysis identifying nine main industry sectors: construction
43 (Alinaitwe, 2009; Shang and Sui Pheng, 2014; Tezel *et al.*, 2018), healthcare (Fine *et al.*, 2009;
44 De Souza and Pidd, 2011; LaGanga, 2011; Drotz and Poksinska, 2014), higher education
45 (Albliwi *et al.*, 2014; Balzer *et al.*, 2016; Rexeisen *et al.*, 2018), IT (Kobus *et al.*, 2018; Shamsi
46 and Alam, 2018; Yadav *et al.*, 2018), manufacturing (Bateman and Rich, 2003; Bhasin, 2012c;
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3 Worley and Doolen, 2015), mixed (Salem *et al.*, 2016; Soliman and Saurin, 2017; Muraliraj *et*
4 *al.*, 2018), public service (Radnor and Walley, 2008; Radnor, 2010; Kregel and Coners, 2018),
5
6 services (Staudacher and Tantardini, 2012; Leite and Vieira, 2015; Sreedharan V. *et al.*, 2018)
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8 and SMEs (Wilson and Roy, 2009; Rymaszewska, 2014; Sahoo and Yadav, 2018).
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17 When classifying the paper into areas and categories specific challenges were encountered. For
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19 example, the service sector is a broad category, which congregates papers found without
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21 specifying any particular area within the service sector, often informed only by the authors as
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23 lean barriers in the service sector. Another example, the public service category draws together
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25 different studies carried out within the public management field. Furthermore, some papers
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27 would present research carried out in several industry sectors, therefore, they fell into a category
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29 named as 'mixed'. Finally, there were papers that did not specify the industry sector, which were
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31 classified in the 'not informed' category.
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35 Figure 4 shows the predominance of studies related to lean barriers in the manufacturing
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37 sector accounted for 37% of the papers. We believe that this is related to the nature and maturity
38
39 of lean thinking, which began on the shop floor of factories (Womack *et al.*, 1990). Similar
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41 results were found by Danese *et al.*, (2018) who consider the manufacturing sector as a mature
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43 and consolidated research setting. The results also report the healthcare sector ranking as second,
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45 with 18% of the studies found in this area. Healthcare is a common theme researched in the lean
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47 concept, in which several scholars have carried out relevant studies, including some significant
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49 literature reviews (Brandao de Souza, 2009; Mazzocato *et al.*, 2010; Burgess and Radnor, 2013a).
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51 Furthermore, research on SMEs and Services, combined, accounts for 15% of the papers found,
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3 and shows the increasing relevance of these two areas. There are also other different industry
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5 sectors that show how these research studies are spread across different areas, such as
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7 construction, higher education, public services and IT, which together account for 12%.
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10 Regardless of the predominance of studies carried out in the manufacturing sector
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12 (n=37%), the scoring of the relevance of the service sector in general is regarded as important.
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14 For example, when considering all industry sectors that are not related to manufacturing
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16 (including SMEs and NI studies), a broader category of services emerges with 35% of the
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18 research studies. This confirms the trend that manufacturing is a mature field of research (Danese
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20 *et al.*, 2018). However, it also informs that the service industries are a prominent field to conduct
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22 new lean studies.
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26 This section of the paper addressed the descriptive analysis of the data, and presented an
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28 important summary of the presence of lean barriers across different geographic regions, the type
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30 of methodologies that have been carried out in lean studies, as well as different industry sectors
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32 that presented lean barriers to research studies. The next section tackles the thematic analysis and
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34 presents the barriers found in literature.
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38 **3.2 Thematic Analysis**

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40 The thematic analysis aims to find meaningful ‘themes’ that emerge from groups of codes. This
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42 is one of the most common approaches amongst scholars carrying out qualitative analysis
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44 (Radnor, 2002; Tranfield *et al.*, 2003; Bell *et al.*, 2018). This phase of the analysis is in line with
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46 RQ2.
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49 In our process of thematic analysis the aim was to find common codes related to lean
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51 barriers, for example, when the barrier lack of resources or financial constraints emerged, they
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53 were individually labelled as codes. This process was sequentially repeated across the entire
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3 database of the papers selected, and a long list of codes related to different lean barriers was
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5 generated.
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8 The next step of our thematic analysis aimed to induce and cluster the relevant codes in
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10 line with each meaningful theme. Thus, the codes were organised according to their repetition in
11
12 literature and were connected to a common subject, and were later merged into broader themes.
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14 Table 1 displays a list of the ten most repeated codes and how they merged into a meaningful
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16 theme. Due to the volume of papers reviewed, naturally a range of related similar codes emerged
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18 which were considered in our analysis. However, for the purpose of illustration, and aiming to
19
20 provide the '*modus operandi*' and rigor of the analysis we have limited the display, in
21
22 alphabetical order, to the ten most common codes related to each of the six themes (Table 1).
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33 The definition of themes is suggested by Braun and Clarke (2006) as a process of identifying the
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35 'essence' of the theme, providing names and aspects captured by each theme. Therefore, as
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37 researchers, we independently examined and reviewed this process of theme definitions, and
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39 after discussing the meaning of each theme, we found some degree of consensus, hence we
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41 identified the themes presented in table 2.
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51 The themes are presented in order of frequency in which they emerged during the thematic
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53 analysis. The 'behavioural and cultural influence' theme accounted for 22.14% of the frequency
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3 during the analysis. This theme related to people's behaviour and culture, and how they constrain
4 lean implementation, for example, the employee's barriers to lean implementation, backsliding
5 and falling into the old ways of working and professional barriers (Čiarnienė and Vienažindienė,
6 2013; Machado Guimarães *et al.*, 2013; Jasti and Kodali, 2016). The 'behavioural and cultural
7 influence' theme is mainly focused on addressing resistances to change that affects lean. For
8 example, Ramadas and Satish (2018), when analysing factors associated with employee barriers
9 in SMEs in China, found that the cultural resistance to change is a strong inhibitor during the
10 implementation of lean. Although, this theme addresses people's behaviour towards lean, it deals
11 with the influence of leadership, which is a specific subject for later discussion.
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24 'Organisational strategy and alignment' is a relevant theme that emerged and occupied
25 the second highest frequency while conducting the data analysis, accounting for 21.84% of the
26 frequency. This theme is related to organisational conduct and influence that affect the lean
27 journey. Some barriers related to this theme are slow pace of change, organisational structure and
28 lack of a clear long-term vision (Radnor *et al.*, 2006; Worley and Doolen, 2015; Belhadi *et al.*,
29 2018). Thus, it addresses issues resulting from inadequate organisational culture, such as poor
30 strategy and vision when implementing lean. When conducting the literature review with the aim
31 of identifying the main challenges faced during lean implementation, Mittal *et al.*, (2016) and
32 Alkhoraif *et al.*, (2018) found inadequate organisational structure as a prevailing inhibitor.
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44 'Technical limitation' accounts for 19.18% of the frequency of the theme, and addresses
45 the tools, knowledge and learning issues associated to lean. Some examples of barriers come
46 from technology-based constraints, lack of knowledge, as well as the lack of a methodology
47 (Kumar, 2014; Jasti and Kodali, 2016; Yadav and Desai, 2017). Moreover, technical limitations
48 emerged from the lack of knowledge and experience with lean philosophy. Piyathanavong *et al.*
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3 (2019) report on barriers related to this theme when assessing lean implementation in
4
5 manufacturers in Thailand. Barriers related to knowledge were also found by Ramadas and
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7 Satish (2018) when carrying out research on SMEs in India.
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10 The 'process-based' theme emerged with 13.57% of frequency in the thematic analysis.
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12 This theme addresses the parts of operations that affect lean implementation, as well as
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14 customers and suppliers. Some of the barriers that emerged during the coding process are poor
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16 supplier integration, transfer of manufacturing concepts to another industry sector, and
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18 fragmented implementation (Dora *et al.*, 2014; De Oliveira *et al.*, 2018; Gao and Gurd, 2019).
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20 When investigating the impact of the operations strategy in the National Healthcare System in
21
22 the UK, Matthias and Brown (2016) reported significant operational hurdles that constrain the
23
24 lean journey in the healthcare sector.
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28 The theme 'leadership commitment' accounted for 12.86% of the frequency of the
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30 thematic analysis, and it deals with the impact of leadership in all levels during lean
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32 implementation and sustainability. During the coding process, several prominent barriers
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34 emerged, such as lack of participation of leadership in lean transformations, lack of awareness
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36 amongst managers and lack of interest by top management (Boyer and Sovilla, 2003; Cherrafi *et*
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38 *al.*, 2016; Yadav *et al.*, 2017). The impact of leadership commitment on lean was found in
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40 different levels of leadership. For example, Nordin *et al.*, (2018) while carrying out a survey with
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42 manufacturers, found a lack of top management support for lean change. There are also other
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44 prominent obstacles to lean, such as insufficient supervisory skills to implement lean, which was
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46 also reported by Bhasin (2012) and Canadian Manufactures and Exporters (2006).
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50 Finally, the theme related to 'resource constraints' accounted for 10.41% of the frequency.
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52 This is a common topic in literature, and addresses the lack of any type of resource during lean
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3 implementation, such as lack of financial and human resources, and lack of time (Albliwi *et al.*,
4 2014; Marodin *et al.*, 2015; Khaba and Bhar, 2018). Literature provides several examples of how
5 the constraint of resources can affect lean implementation and sustainability, for instance,
6 Bateman and Rich (2003), when carrying out a survey amongst British manufacturers, found the
7 lack of equipment and people as a barrier to the lean journey.
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10 This section synthesised the findings of our study, addressing the thematic analysis. The
11 results showed that there are several barriers related to lean. Frequently, these barriers present
12 similarities and overlaps, without significant differences in meaning. Therefore, we categorised
13 these barriers into codes that were later clustered into six main themes, this represents
14 meaningful barriers that constrain the lean journey. The next section provides an in-depth
15 discussion of these results.
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31 **4. Discussion and propositions**

32 The findings of our study show that there are several inhibitors that constrain the lean journey.
33 This variety of challenges also shows that there is no unique recipe for implementing lean and
34 succeeding, or as argued by Dixon-Wood and Martin (2016, p. 193) there is no '*magic bullet*'.
35 Indeed, every organisation is different in terms of sector, product and service, therefore, a
36 replication of another organisation's lean process is a mistake, since lean depends on context and
37 culture, organisational pressures, and supporting infrastructures vary between companies (Dixon-
38 Woods *et al.*, 2011; Bhasin, 2012a; Radnor and Osborne, 2013; Leite and Vieira, 2015). Thus,
39 we argue that the barriers that constrain lean implementation should be addressed individually,
40 considering their impact within the organisation. Our study found six main barriers that emerged
41 from the data analysis: 'behavioural and cultural influence', 'organisational strategy and
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3 alignment', 'leadership commitment', 'technical limitation', 'process-based', and 'resource
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5 constraints'. This categorisation does not aim to generalise barriers, but rather proposes a clear
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7 focus on organisational aspects.
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10 Since lean is context-dependent (Radnor *et al.*, 2012), it is important to acknowledge that
11 these barriers have different restraining forces in different settings and organisations. Thus, to
12 understand and explain the interplay and impact of these barriers within the organisation, we
13 designed an organisational framework to identify the barriers according to their nature and
14 influence (Figure 5). The framework using the six themes (table 2) is divided into two levels,
15 which makes an analogy of the elements that are visible, above the surface (technical aspects,
16 and therefore, the tool-based approach), and elements that are less visible, underneath the surface
17 (behavioural and organisational aspects, and therefore, those depending on people). This type of
18 approach, with levels of visibility of the elements in a framework, draws on the work by Hines *et al.*
19 (2011, p. 9) when explaining their 'Lean Sustainable Iceberg Model', which address only
20 enablers for lean implementation. There are also other fragmented studies that highlight the
21 categories of ostensible barriers (barriers that apparently are responsible for causing a problem,
22 but not necessarily so (Leite *et al.*, 2019)) on people, and organisational and technical aspects
23 (Jina *et al.*, 1997; Brandao de Souza, 2009; De Souza and Pidd, 2011; Čiarnienė and
24 Vienažindienė, 2013; Kinder and Burgoyne, 2013b; Vienažindienė and Čiarnienė, 2013;
25 Tortorella *et al.*, 2018; Yadav *et al.*, 2018; Leite *et al.*, 2019). Our framework focuses on barriers,
26 and considers the prominent hurdles that might influence the lean journey in different technical,
27 behavioural and organisational aspects. The categorisation of the barriers into an organisational
28 framework is in line with our RQ3.
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8 The bottom level of the framework addresses three barriers that are related to ‘behavioural and
9 organisational aspects’, which are considered less visible and are people dependent. The first
10 barrier in this level is the ‘behavioural and cultural influence’, which is related to people’s
11 behaviour and culture. Some examples of inhibitors that come from this barrier are resistance to
12 change (Bateman and Rich, 2003), people backsliding and falling into old ways of working
13 (Emiliani and Stec, 2005), and lack of interest and commitment (Radnor *et al.*, 2006). Some
14 scholars address this type of barrier as a human or people-related barrier (Čiarnienė and
15 Vienažindienė, 2013; Heno *et al.*, 2019), due to its impact on human behaviour during lean
16 implementation (Sahoo and Yadav, 2018). The understanding of this barrier is relevant to enable
17 future implementation; according to Chougule *et al.* (2011) the behavioural and cultural
18 influence can guide people into providing information about the organisation’s current
19 shortcomings in sustaining change, associating this to a lean enabler, rather than an inhibitor. In
20 this regard, Knight and Haslam (2010) consider that the commitment and motivation of those
21 involved in the lean journey allow the empowerment of employees, who are the ones that
22 promote the actual change on the shop floor (Angelis *et al.*, 2011; Savage *et al.*, 2016). This
23 leads us to our first proposition related to behavioural and cultural influence:
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47 Proposition 1: Peoples’ behaviour and culture during lean implementation is a strong inhibitor
48 and can lead to various types of resistance. However, when directed correctly, it can enable
49 empowerment and sustainable change.
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3 The second barrier in this level is ‘organisational strategy and alignment’, and this inhibitor
4 represents issues related to organisational conduct and influence in lean implementation and
5 sustainability. Some examples of inhibitors are insufficient to understand the potential benefits
6 (Bhasin, 2012b, 2013b), lack of long term-strategy (Sisson and Elshennawy, 2015b), and rigid
7 organisational culture (Radnor and Boaden, 2008). The way in which the organisation leads the
8 change is the key element to overcome these challenges, for instance, creating a lean
9 environment in an organisation involves changing its strategy, becoming a lean-thinking, rather
10 than problem-solving based organisation (Bhasin and Burcher, 2006; Jain and Ajmera, 2019).
11 Thus, supportive organisational strategies and alignments are essential to implement successful
12 lean initiatives, as they help to build confidence, ease cultural changes and become aligned with
13 the new improvement system (Bhasin, 2013b Achanga et al., 2006; Rise and Haddud, 2016;
14 Escuder *et al.*, 2018). This leads us to our second proposition towards organisational conduct and
15 strategy:

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36 Proposition 2: In order to promote lean thinking across the organisation, it is important to
37 develop a supportive and organisational strategy which aligns and promotes sustainable cultural
38 changes towards a new mind-set of process improvement.
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45 The last barrier in this level is ‘leadership commitment’. This addresses the impact of low,
46 medium and top leadership during the lean journey. Some examples of this barrier are the lack of
47 top management’s support and commitment (Jadhav *et al.*, 2015), leadership’s resistance to
48 change (Lean Enterprise Institute, 2007), and leadership’s participation (Emiliani and Stec, 2005).
49 The leadership team conveys the organisation’s strategy. They are the ones that influence those
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3 involved in direct change and encourage change (Drotz and Poksinska, 2014; Tortorella *et al.*,
4 2018). If leadership is not entirely engaged and presents signs of lack of commitment, this will
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6 have a direct impact on ‘shop floor’ workers, consequently, making the changing process more
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8 difficult as there is no reference to follow (Bicheno and Holweg, 2009; Atkinson, 2010). Thus,
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10 the leadership team must be selected carefully, considering attributes, such as ownership,
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12 demonstration of commitment and enthusiasm towards the change process (Atkinson, 2014; Rise
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14 and Haddud, 2016; Nogueira *et al.*, 2018). Leadership style and attitude have a positive impact
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16 on the lean journey, and based on this, we derive our third proposition.
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24 Proposition 3: The process of change starts with the definition of a consistent, engaged and
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26 motivated leadership team that will convey the organisation’s strategy towards those directly
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28 performing the lean improvements.
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33 The barriers that appear in the bottom level of the framework are underneath the surface,
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35 therefore, they are less visible, and as a result more difficult to identify. These barriers are also
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37 dependent on people’s behaviour, which means that decisions and strategies do not rely on tools
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39 or techniques, but on the strategy defined by people instead. This type of situation was identified
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41 by Rise and Haddud (2016) when investigating the impact of organisational culture on small
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43 family-owned manufacturing businesses. They found that lean implementation is highly
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45 influenced by the values and beliefs of their founders and owners. Furthermore, the impact of
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47 corporate culture was also found by Bhasin, (2013b) as a prominent inhibitor of lean success in
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49 British manufacturers. In the public service, the organisational structure was also underscored as
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51 a strong inhibitor of lean practices (Radnor and Boaden, 2008; Radnor, 2010).
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3 Organisationsal conduct is defined by people's individual thinking, attitudes and
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5 behaviour that have actions of self-interest to express influence or force (Schilling and Kluge,
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7 2009; Ainul Azyan *et al.*, 2017). This behaviour is people dependent, and it conveys the
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9 intangible organisationsal strategy, which is difficult to identify during the lean journey. From this,
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11 we derive our fourth proposition related to barriers placed underneath the surface that are
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13 dependent on people:
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19 Proposition 4: The barriers related to behavioural and organisationsal aspects are dependent on
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21 people, therefore, they are more difficult to identify and tackle, and have a huge impact on lean
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23 implementation and sustainability.
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28 The upper level of the framework addresses the three barriers related to the 'technical aspects',
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30 which are easier to see as they are tool-based barriers. For example, the first barrier in this level
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32 is 'technical limitation' which raises obstacles related to knowledge, tools and learning issues.
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34 Examples of these barriers are insufficient know-how (Sim and Rogers, 2008), lack of training
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36 (DeSanctis *et al.*, 2018), and lack of knowledge (Zimmermann and Bollbach, 2015). There are
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38 several critics who state that lean cannot be implemented as a 'tool-based approach' (Spear,
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40 2004; Burgess and Radnor, 2013a), and which is argued leads to piecemeal implementation.
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42 However, it is also important to acknowledge that it is essential to provide adequate and effective
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44 training on suitable lean methodologies and tools. There are some misunderstandings related to
45
46 lean, which lead companies to focus only on specific tools or aspects of the implementation,
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48 therefore, jeopardizing the potential benefits of a complete lean project across the organisation
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50 (Dora *et al.*, 2016b; Panwar *et al.*, 2016; Zhang *et al.*, 2017). The lean approach should not focus
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3 on replicating specific tools, but equipping employees with a holistic knowledge, so they can act
4 as effective problem-solvers. Therefore, providing training and teaming up with experienced
5 people to deploy lean sustainable initiatives is an enabler to overcome technical limitation
6 (Radnor and Walley, 2008; Bhasin, 2012c; Radnor *et al.*, 2012; Aij *et al.*, 2013b; Escuder *et al.*,
7 2018). Based on this, we derive our fifth proposition:
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17 Proposition 5: Organisations embarking on the lean journey must avoid excessive focus only on
18 tools and techniques. Instead, they should equip employees with lean holistic knowledge,
19 otherwise lean implementation risks may be fragmented, without a strategy for long-term
20 improvement and sustainability.
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28 The second barrier in this level is ‘process-based’. It creates barriers that come from operations,
29 customers and suppliers’ interplay. Some examples are difficulties in transferring manufacturing
30 concepts to another industry sector (Gao and Gurd, 2019), uncertainties in demand (Hacker and
31 Doolen, 2005), and poor supplier integration (Dora *et al.*, 2014). These barriers that are ‘process-
32 based’ can influence how lean is implemented and sustained in different industries. For example,
33 sometimes manufacturers have to deal with demand variability from customers’ orders and weak
34 supplier performance. This leads to low standardisation of the operations, and poor integration of
35 the customers and suppliers in the lean project (Wilson and Roy, 2009; Eswaramoorthi *et al.*,
36 2011; Zimmermann and Bollbach, 2015b). In the service sector, the process is highly affected by
37 customer interaction, also known as co-production (Edvardsson and Olson, 1996; Osborne *et al.*,
38 2012), and this creates challenges to keep the process standardised, thus affecting the operations.
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54 One of the difficulties is to understand customer interactions in the service industry. For instance,
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3 Grove *et al.* (2010) when investigating a case study in the British public healthcare, found
4 difficulty in determining who the customer was and what they valued . Therefore, to overcome
5 inhibitors that are ‘process-based’ it is necessary to have clear customer and value identification,
6 as well as supplier integration (Radnor and Boaden, 2008; Machado Guimarães *et al.*, 2013;
7 Jadhav *et al.*, 2014; Cheng *et al.*, 2015). This leads us to our sixth proposition:
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17 Proposition 6: Customers and suppliers are key elements that affect standardised operations in
18 service and manufacturing sectors. Therefore, when implementing lean, the impact of these
19 elements must be identified in the value stream, in order to ease future inhibitors.
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26 The last barrier in this level is ‘resource constraints’. The inhibitors in this level involve every
27 type of resource required in the organisation during the lean journey, including availability of
28 time (Nordin *et al.*, 2018), lack of human resources (Marodin and Saurin, 2015), and financial
29 constraints (Caldera *et al.*, 2019). In literature, this is a common obstacle for the lean success.
30
31 Several scholars agree that the allocation of resources is essential to fund and promote
32 improvement programmes across the organisation (Nordin *et al.*, 2012; Bhasin, 2013b; Kumar
33 and Kumar, 2015; Ainul Azyan *et al.*, 2017; Yadav *et al.*, 2018). Improvement initiatives, such
34 as lean programmes, demand different types of funding. They might come from different areas of
35 the organisation, but in general they involve the investment of time, availability of human
36 resources and financial resources to support the changes needed (Bateman and Rich, 2003;
37 Sisson and Elshennawy, 2015a; DeSanctis *et al.*, 2018). Because resource constraints affect and
38 might hinder lean implementation, it might be regarded as the easiest barrier to identify amongst
39 the technical aspects of the organisational framework (Figure 5). As regards to the strategic
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3 relevance of the resources, there is a theory that specifically addresses the impact of resources in
4 the organisation, which is the resource-based view (RBV) (Colbert, 2004). RBV scholars argue
5 that when resources are allocated to the right purpose, they enable firms to implement
6 sustainable strategies that represent a competitive advantage for the organisation (Priem and
7 Butler, 2001; Halawi *et al.*, 2005). Thus, based on this consideration, we derive our seventh
8 proposition:
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19 Proposition 7: Resources are essential elements to fund and promote change in the lean journey,
20 therefore, they should be strategically allocated to enable changes and sustainable improvements
21 across the organisation.
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28 The barriers that appear in the upper level of the framework are above the metaphorical surface,
29 and therefore, they are considered visible elements that are easier to identify (Figure 5). In the
30 framework, it is possible to understand that these barriers are usually based on tools and
31 techniques. Reijula and Tommelein (2012) advocate that this type of barrier will be easier to
32 solve in the short-term, since the need of tools and supplies are easier to identify. This represents
33 an approach on visible elements, that are also known in literature as the 'tool-based approach'
34 and focus on the problem-solving culture (Spear, 2004; Radnor and Walley, 2010; Hines *et al.*,
35 2011; Burgess and Radnor, 2013). Our study acknowledges that focusing only on these types of
36 barriers might help the implementation in the short-term, but it has a negative impact in the long-
37 term. Therefore, one that is embarking on the lean journey should avoid focusing only on a 'tool-
38 based approach', but should consider a holistic approach instead (Bhasin, 2011; Matthias and
39 Brown, 2016).
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3 The barriers related to technical aspects are easier to identify in comparison to
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5 behavioural and organisational aspects. For example, the lack of resources will be immediately
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7 perceived when investment is not made in the lean journey (Jaiprakash Bhamu, 2016; Zhang *et*
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9 *al.*, 2017). Moreover, the difficulties to establish customer and supplier integration, as well as the
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11 challenges to implement certain tools and techniques, will make the barriers of technical
12
13 limitation more visible (Mishra and Chakraborty, 2015; Yadav and Desai, 2017). Nevertheless,
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15 this ‘tool-based approach’ has been criticised in literature, because it creates fragmented
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17 implementations, based on tools and technology that are not sustained, rather than create a long-
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19 term sustainable strategy for lean (Bhasin and Burcher, 2006; Radnor *et al.*, 2012; Reijula and
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21 Tommelein, 2012; Burgess and Radnor, 2013a; Coetzee, *et al.*, 2018; Pearce *et al.*, 2018).
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26 This approach that categorises the barriers into behavioural and organisational, as well as
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28 technical aspects, echoes other studies that have investigated the impact of these barriers (Bhasin
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30 and Burcher, 2006; Nordin *et al.*, 2012; Vienažindienė and Čiarnienė, 2013). Similarly, due to
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32 the fact that lean is context dependent, and its implementation should consider contextual
33
34 elements (Dixon-Woods *et al.*, 2011; Bhasin, 2012a; Radnor and Osborne, 2013), the approach to
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36 these barriers should consider both tool-based and people dependent barriers, according to the
37
38 environment. One of the reasons for the low success factors of lean implementation it could be
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40 argued is, to focus on only one side of the framework, i.e. focusing on either visible or less
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42 visible elements (Bhasin and Burcher, 2006; Vienažindienė and Čiarnienė, 2013; Tortorella *et al.*,
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44 2017). From this perspective we derive our last proposition based on the interplay of behavioural,
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46 organisational, and technical barriers, and their impact on lean journey:
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3 Proposition 8: These barriers interact and influence each other in different degrees, therefore, to
4 avoid a weak foundation of process improvement programmes, it is important to promote change
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6 in both the technical and socio-cultural aspects
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12 The barriers underscored in the framework are not isolated inhibitors, but they have a degree of
13 interplay. The arrows in figure 5 illustrate this relationship between the barriers and levels. For
14 instance, resource constraints might be motivated due to an organisational decision to reduce
15 investments; or a behavioural element, such as resistance to change, might be motivated by a
16 technical limitation that creates frustration towards lean.
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24 In a nutshell, in this section, we tackled the impact and interplay of the six main barriers that
25 constrain the lean journey, providing propositions for each barrier in the organisational
26 framework, which addresses RQ4 of our study.
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33 **5. Conclusions**

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35 This is a systematic literature review of 204 papers that aimed to identify the main barriers that
36 constrain the lean journey in an organisational framework, identifying their interplay, impact and
37 contribution. These aims have been addressed deriving four research questions that convey the
38 contributions of our study.
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45 In RQ1, we addressed the current outline of lean barriers in literature. This was achieved
46 through the undertaking of a meticulous, descriptive analysis of the data, as suggested by
47 Tranfield *et al.*, (2003). Starting from this analysis, we found key elements that show the main
48 trends in literature, such as the geographic distribution of publications, diversity of the
49 methodological approaches carried out, and type of industry sectors that have encountered lean
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3 barriers. As regards to the geographic distribution of publications (Figure 2), we found that 47%
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5 of the publications were concentrated in three regions: Europe, the Americas and Asia. Even
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7 though Europe leads in number of publications, it has a slight difference of only 4% when
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9 compared to the other two leading regions. There are other prominent regions with a small
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11 number of publications, such as Scandinavia and the Middle East, thus, we understand that these
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13 regions represent opportunities for future research, as well as for cross-country studies.
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17 As regard to the methodologies carried out to investigate lean barriers, we found the main
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19 methodologies in this order of appearance: literature review, case study, survey, action research,
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21 mixed methods and focus group (Figure 3). The results show the prevalence (n=84%) of
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23 common methodologies (case study, literature review and survey) as preferable methods to
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25 investigate the inhibitors that affect lean implementation and sustainability. Regardless of the
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27 prevalence of these three methods, it is important to acknowledge that our research found a
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29 plurality of other methods carried out to investigate lean barriers.
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33 Finally, the descriptive analysis addressed the heterogeneity of industry sectors that have
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35 investigated lean barriers (Figure 4). We found nine different industry sectors, with a prevalence
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37 of studies in the manufacturing sector (n=37%) and healthcare (n=18%). These results confirm
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39 the trends in literature; first, it addresses the nature of lean on the shop-floor, and the maturity
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41 that lean studies have reached in the manufacturing sector (Womack *et al.*, 1990; Danese *et al.*,
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43 2018); second, it confirms the importance of the healthcare sector as one of the most prominent
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45 areas for lean studies (Brandao de Souza, 2009; Mazzocato *et al.*, 2010; Burgess and Radnor,
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47 2013a). Moreover, when considering all industry sectors that could be categorised as ‘service’,
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49 we found that 35% of the studies could be classified in this category. This exemplifies the
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3 relevance of the service sector for future investigation of lean barriers and challenges (Bowen
4 and Youngdahl, 1998; Leite and Vieira, 2015).

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8 In RQ2, we addressed the meaningful barriers that constrain lean implementation and
9 sustainability. To answer this research question and provide contributions to our study, we
10 carried out a thematic analysis across the literature selected (Tranfield *et al.*, 2003; Braun and
11 Clarke, 2006). Codes and themes emerged from this thematic analysis (Table 1). The codes
12 represent lists of lean barriers found in literature, and from these codes' six themes, which indeed
13 represent meaningful barriers, emerged: 'behavioural and cultural influence', 'organisational
14 strategy and alignment', 'leadership commitment', 'technical limitation', 'process-based', and
15 'resource constraints' (Table 2). We found a saturation of research related to lean barriers in
16 literature. Most of the studies provide lists of lean barriers that overlap, which is illustrated in
17 Table 1. The first novelty of our study provides meaningful barriers that summarise these
18 overlapping barriers.
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33 In RQ3, we categorised six meaningful barriers in an organisational framework (Figure
34 5), and in RQ4, we discussed the impact and interplay of these barriers. Thus, from this we
35 derived eight propositions that contribute to knowledge and practice. This provides additional
36 novelty to our study, when compared to similar literature reviews of lean barriers (Bhasin and
37 Burcher, 2006; Nordin *et al.*, 2012; Vienažindienė and Čiarnienė, 2013; Hu *et al.*, 2015;
38 Tortorella *et al.*, 2018; Yadav *et al.*, 2018). Figure 5 illustrates the organisational framework, in
39 which the barriers were separated into two levels of metaphorical surfaces. The barriers
40 underneath the surface represent behavioural and organisational aspects that are people
41 dependent and, therefore, are more difficult to identify and tackle (Schilling and Kluge, 2009;
42 Ainul Azyan *et al.*, 2017). These barriers that are related to behavioural and organisational
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3 aspects have a major impact on lean implementation and sustainability. Thus, from the literature
4 researched we derived propositions 1, 2, 3 and 4 to address these inhibitors and provide some
5 degree of guidance towards the lean journey.
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10 The barriers above the surface embody technical aspects that are tool-based and,
11 therefore, are easier to identify and tackle. One of the concerns related to barriers in this level is
12 the creation of a culture limited to problem-solving, which might help lean implementation in the
13 short-term, but has a negative impact in the long-term (Spear, 2004; Radnor and Walley, 2010;
14 Hines *et al.*, 2011; Burgess and Radnor, 2013). Thus, based on the literature and data analysis,
15 we derived propositions 5, 6, 7 and 8, to address the impact of these tool-based barriers and
16 encourage a holistic approach to ease lean inhibitors.
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26 A general conclusion is that the aims of this study were achieved, as the research
27 questions were answered and discussed in line with the findings in literature. From the results of
28 this study, we contribute to the discipline of operations management, by providing invaluable
29 theoretical (knowledge and academics) and practical (lean practitioners) contributions. The
30 contributions to knowledge and academics are based on the new body of knowledge related to a
31 categorisation of several common lean barriers into meaningful barriers that have an impact on
32 organisations. Moreover, this work has provided a framework that shows the interplay between
33 barriers and elements within an organisation. Some barriers have a strong influence on the
34 behavioural and organisational aspects, whereas others have an impact on the technical aspects.
35 From this, we derived propositions that tackle these inhibitors, and are basis for further research.
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49 inhibitors.

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51 Contributions to lean practitioners consider the impact of these six barriers on lean
52 implementation and sustainability. The results showed that barriers that are dependent on people
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3 are more difficult to identify and have a great impact on lean. Whilst tool-based barriers are
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5 easier to identify and tackle, they also jeopardize the lean journey, creating a fragmented
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7 implementation that in the long-term cannot be sustained. Thus, we suggest that lean managers
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9 should rethink the way that value is addressed during the implementation and focus on
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11 meaningful elements of the organisation that might provide a holistic and sustainable lean
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13 implementation.
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17 Furthermore, these contributions together with the research outcome, motivate
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19 suggestions for future research on lean barriers. First, we suggest future research addressing the
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21 impact of the context in which these barriers emerge. For instance, in the service sector, co-
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23 production is a strong element that has an influence on operations. Therefore, behavioural and
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25 organisational aspects that are people dependent might present a greater impact in this setting.
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27 Whereas, in the manufacturing sector where there is less or no co-production, technical aspects
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29 might present greater impact on the lean journey. Second, as some of our finding suggests a
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31 shortage of research in some regions, we recommend future research on lean barriers considering
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33 different contexts, such as Africa, the Middle East, Oceania and Scandinavia. Third, we suggest
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35 in-depth investigations of lean barriers using a different methodological approach, such as
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37 Action Research, Focus Group and Mixed Methods. This type of method presented a
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39 misrepresentation in our findings; therefore, we believe that research in this area could bring
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41 relevant findings. Finally, we suggest further investigation in the healthcare sector, which is an
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43 area that is attracting a variety of lean research, and our findings showed that it is a prominent
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45 area of services. Therefore, studies in the public and private healthcare that investigate the six
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47 main barriers found in this study might bring relevant contribution to knowledge and practice.
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3 In conclusion, we understand that every piece of research has limitations and strengths.
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5 As regards to the limitations, we aimed to find only publications related to predefined keywords
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7 in the title, abstract and keywords of the papers. Therefore, it is possible that papers that only
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9 presented the predetermined keywords in the body of the article were excluded. Moreover, the
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11 terminology related to lean and its barriers might be limited. Although we have predefined the
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13 keywords based on literature, for the searching process, it may be possible that we have not
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15 considered a different or new terminology related to lean barriers. In this case, we recognize that
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17 some publications may have been excluded from our study. Regardless of the limitations of this
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19 work, the strengths of the study also present the trustworthiness and rigor of the study. We
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21 developed and undertook a meticulous research protocol based on the experience of several
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23 scholars that have published a systematic literature review. Therefore, we understand that the
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25 rigorous methodology, carried out in this study, creates the trustworthiness of the research and
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27 helps to control and ease some of its limitations.
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3 **Meaningful inhibitors of the Lean journey: A Systematic Review and**
4 **categorisation of over 20 years of literature**
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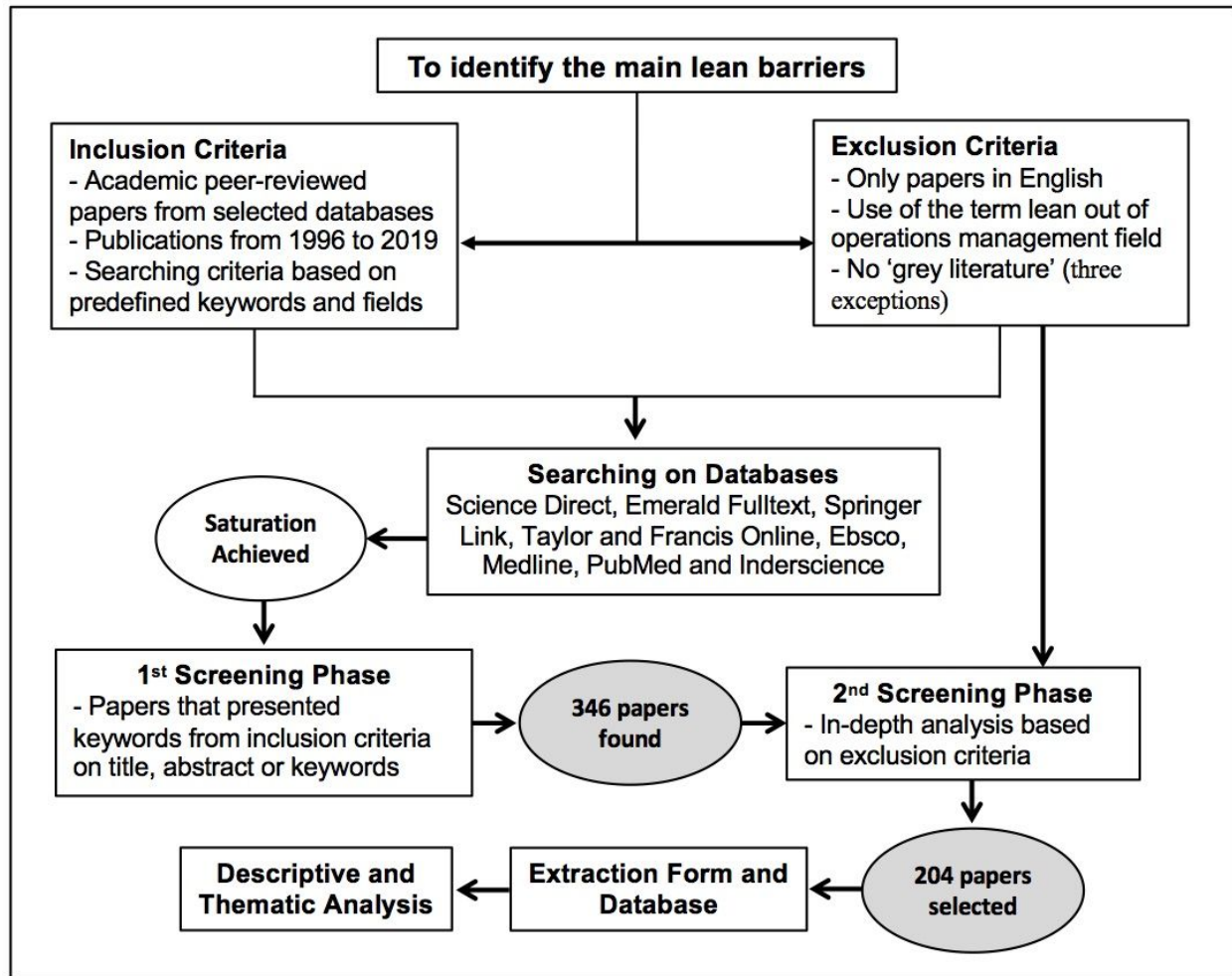
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Figure 1 - Framework of the Research Review Protocol



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Figure 2 – Percentage of papers by geographic region

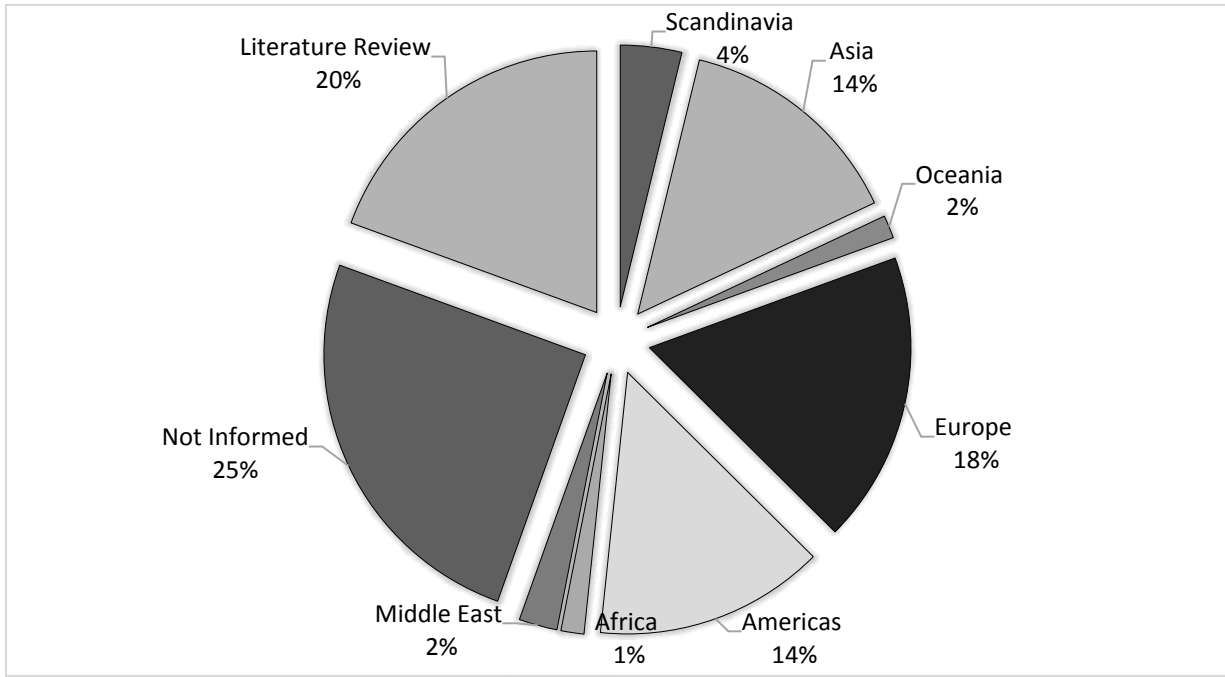


Figure 3 - Percentage of papers by methodology

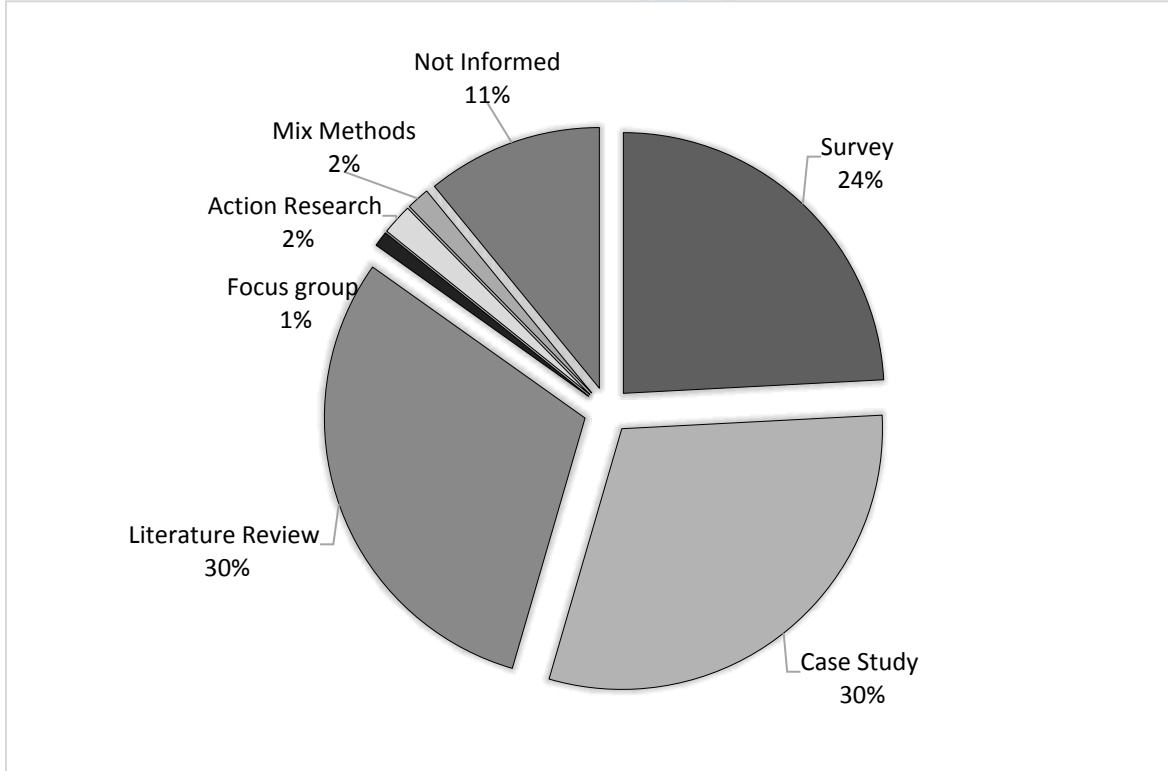


Figure 4 – Percentage of papers by sector

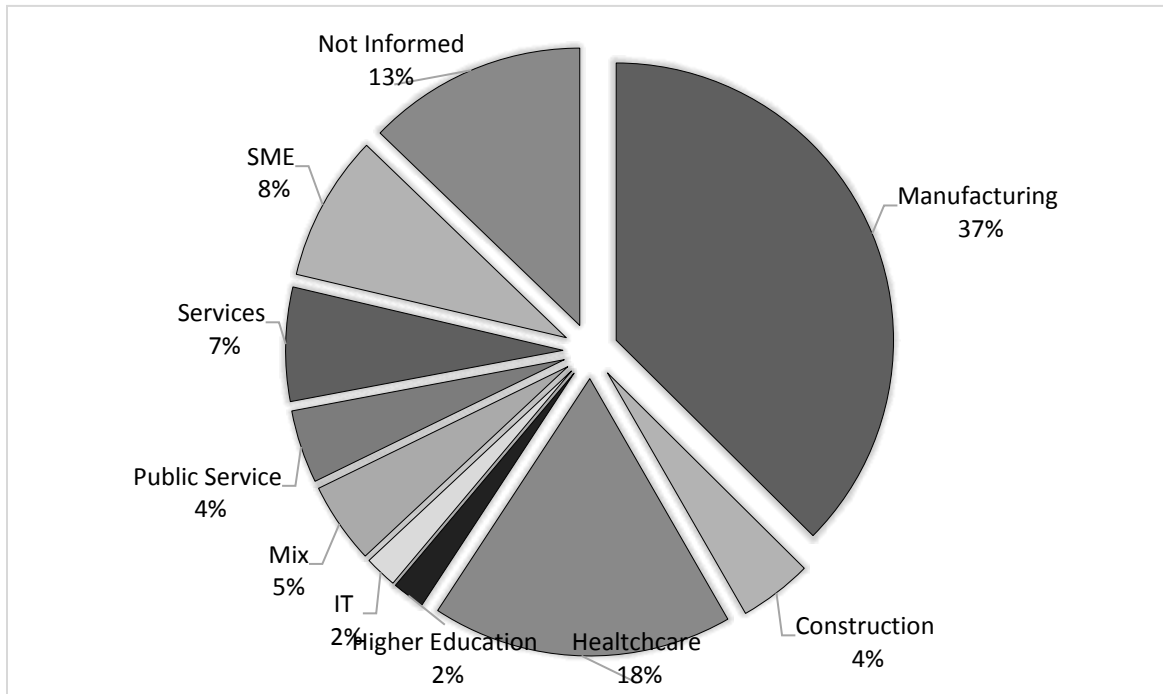


Figure 5 – Organisational framework of the lean barriers

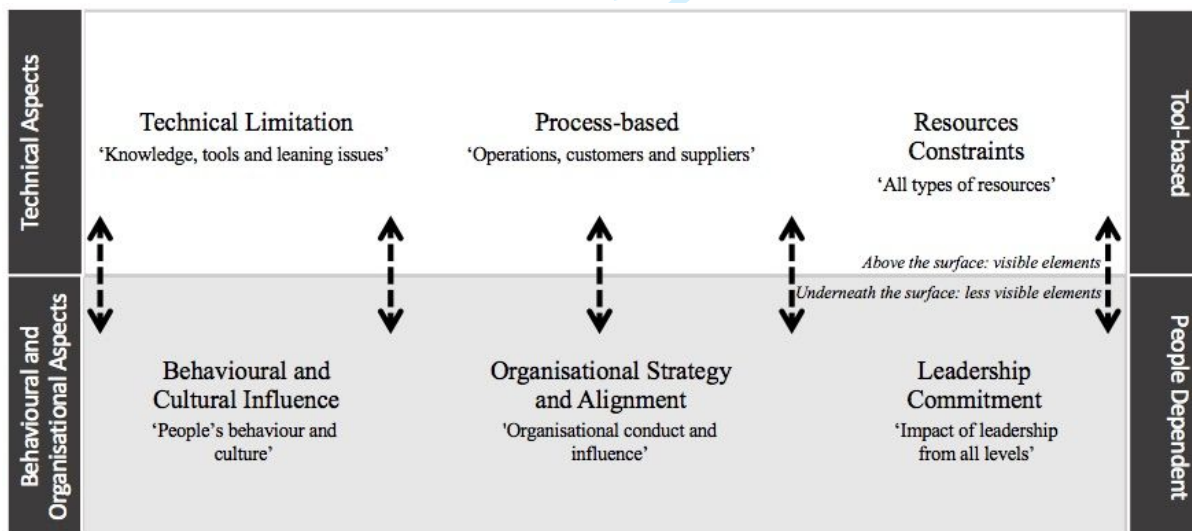


Table 1 – Thematic Analysis – Coding process

Themes	Codes	Sources
Behavioural and cultural influence	<ul style="list-style-type: none"> • Backsliding to old ways of working; • Cultural issues; • Fear of failure; • Job security; • Lack of interest and commitment; • People-related issues; • Personal conflicts; • Resistance to change; • Social-cultural barriers; • Staff behaviors; 	<p>(Barker, 1998; Deloitte and Touche, 2002; Boyer and Sovilla, 2003; Bateman and Rich, 2003; Lucey and Hines, 2005; Canadian Manufactures and exporters, 2006; Kim <i>et al.</i>, 2006; Radnor <i>et al.</i>, 2006; Radnor and Walley, 2008; Rogers and McQuilkin, 2008; Sim and Rogers, 2008; Fine <i>et al.</i>, 2009; Atkinson, 2010; Poksinska, 2010; Angelis <i>et al.</i>, 2011; Cudney and Elrod, 2011; de Souza and Pidd, 2011; Hodge <i>et al.</i>, 2011; Rossiter <i>et al.</i>, 2011; Bhasin, 2011; Nordin <i>et al.</i>, 2012; Staudacher and Tantardini, 2012; Aij <i>et al.</i>, 2013; Bhasin, 2013; Fernandez-Solis <i>et al.</i>, 2013a; Kinder and Burgoyne, 2013; Machado Guimarães <i>et al.</i>, 2013; Drotz and Poksinska, 2014; Jadhav <i>et al.</i>, 2014; Timmons, <i>et al.</i>, 2014; Bhamu and Sangwan, 2014; Zimmermann and Bollbach, 2015; Jasti and Kodali, 2016; Lindskog <i>et al.</i>, 2016; Rane <i>et al.</i>, 2016; Balzer <i>et al.</i>, 2016; Cherrafi <i>et al.</i>, 2017; Madsen <i>et al.</i>, 2017; Yadav and Desai, 2017; Coetzee <i>et al.</i>, 2018; Fournier and Jobin, 2018; Aoun <i>et al.</i>, 2018; Pearce <i>et al.</i>, 2018; Rexeisen, 2018; Yadav <i>et al.</i>, 2018; Belhadi <i>et al.</i>, 2018; Henao <i>et al.</i>, 2019; Isfahani <i>et al.</i>, 2019)</p>
Organisational strategy and alignment	<ul style="list-style-type: none"> • Company strategy; • Communication; • Insufficient understanding of potential benefits; • Lack of alignment; • Lack of long-term strategy; • Organisational barriers; • Organisational culture; • Organisational structure; • Slow pace of change; • Unclear goals and too many targets; 	<p>(Emiliani and Stec, 2005; Radnor <i>et al.</i>, 2006; Kim and Park, 2008; Radnor and Boaden, 2008; Walley, 2008; Wilson and Roy, 2009; Grove <i>et al.</i>, 2010; Atkinson, 2010; Cudney and Elrod, 2011; Vienažindienė and Čiarnienė, 2013; Bhasin, 2013; Albliwi <i>et al.</i>, 2014; Kumar and Kumar, 2015; Kumar <i>et al.</i>, 2015; Sisson and Elshennawy, 2015; Worley and Doolen, 2015; Anholon and Sano, 2016; Mittal <i>et al.</i>, 2016; Dora <i>et al.</i>, 2016; Madsen <i>et al.</i>, 2017; Rymaszewska, 2017; Yadav and Desai, 2017; Ferenhof <i>et al.</i>, 2018; Sreedharan <i>et al.</i>, 2018; Stankalla <i>et al.</i>, 2018; Wilson <i>et al.</i>, 2018; Coetzee <i>et al.</i>, 2018; Costa <i>et al.</i>, 2018; Leong <i>et al.</i>, 2019)</p>
Leadership commitment	<ul style="list-style-type: none"> • Insufficient supervisory skills; • Lack of awareness amongst managers; • Lack of top management support and commitment; • Leadership resistance to change; • Leadership participation; 	<p>(Bateman and Rich, 2003; Boyer and Sovilla, 2003; Emiliani and Stec, 2005; Canadian Manufactures and exporters, 2006; Radnor <i>et al.</i>, 2006; Lean Enterprise Institute, 2007; Sim and Rogers, 2008; Wilson and Roy, 2009; Grove <i>et al.</i>, 2010; Bhasin, 2011; Wong and Wong, 2011; Hines <i>et al.</i>, 2011; Nordin <i>et al.</i>, 2012; Staudacher and Tantardini, 2012; Bhasin, 2012; Čiarnienė and Vienažindienė, 2013; Dora <i>et al.</i>, 2014; Bateman <i>et al.</i>, 2014; Kumar, 2014; Balzer <i>et al.</i>, 2015; Gelei <i>et al.</i>, 2015; Jadhav <i>et al.</i>, 2015; Kumar and Kumar, 2015; Marodin <i>et al.</i>, 2015; Mishra and Chakraborty, 2015; Bertani <i>et al.</i>, 2015; Winkel <i>et al.</i>, 2015; Jaiprakash</p>

	<ul style="list-style-type: none"> • Loss of interest by top management; • Managerial style; • Middle management resistance; • Pressure from top management; • Senior management commitment; 	Bhamu, 2016; Rafique <i>et al.</i> , 2016; Upadhye <i>et al.</i> , 2016; Cherrafi <i>et al.</i> , 2016; Panwar <i>et al.</i> , 2016; Cherrafi <i>et al.</i> , 2017; Yadav <i>et al.</i> , 2017; Escuder <i>et al.</i> , 2018; Khaba and Bhar, 2018; Kregel and Coners, 2018; Muraliraj <i>et al.</i> , 2018; Mustapha <i>et al.</i> , 2018; Nassereddine and Wehbe, 2018; Nordin <i>et al.</i> , 2018; Ruben <i>et al.</i> , 2018; Sreedharan <i>et al.</i> , 2018; Stankalla <i>et al.</i> , 2018; Thanki and Thakkar, 2018; Leong <i>et al.</i> , 2019)
Technical limitation	<ul style="list-style-type: none"> • Education; • Insufficient know-how; • Lack of experience; • Lack of knowledge and expertise; • Lack of methodology; • Lack of workforce skills; • Lean terminology; • Limited lean understanding; • Technology-based; • Training; 	(Rogers and McQuilkin, 2008; Sim and Rogers, 2008; De Souza and Pidd, 2011; Deflorin and Scherrer-Rathje, 2012a; Reijula and Tommelein, 2012; Fernandez-Solis <i>et al.</i> , 2013b; Machado Guimarães <i>et al.</i> , 2013; Bhasin, 2013; Čiarnienė and Vienožindienė, 2013; Dora <i>et al.</i> , 2014; Hadid and Mansouri, 2014; Albliwi <i>et al.</i> , 2014; Jadhav <i>et al.</i> , 2014; Kumar, 2014; Marodin and Saurin, 2015; Mishra and Chakraborty, 2015; Bertani <i>et al.</i> , 2015; Worley and Doolen, 2015; Zimmermann and Bollbach, 2015; Chay <i>et al.</i> , 2015; Abolhassani <i>et al.</i> , 2016; Deblois and Lepanto, 2016; Hadid, <i>et al.</i> , 2016; Jasti and Kodali, 2016; Ainul Azyan <i>et al.</i> , 2017; Yadav and Desai, 2017; Zhang <i>et al.</i> , 2017; De Oliveira <i>et al.</i> , 2018; DeSanctis <i>et al.</i> , 2018; Edison <i>et al.</i> , 2018; Hihnala <i>et al.</i> , 2018; Lauver <i>et al.</i> , 2018; Alkhoraif <i>et al.</i> , 2018; Nassereddine and Wehbe, 2018; Nogueira <i>et al.</i> , 2018; Ramadas and Satish, 2018; Ruben <i>et al.</i> , 2018; Stankalla <i>et al.</i> , 2018; Vlachos and Siachou, 2018; Weerasooriya <i>et al.</i> , 2018; Costa <i>et al.</i> , 2018; Piyathanavong <i>et al.</i> , 2019; Sindhwani <i>et al.</i> , 2019; Caldera <i>et al.</i> , 2019)
Process-based	<ul style="list-style-type: none"> • Fragmented implementation; • Lack of focus on customer and process; • Lack of metrics; • Lack of standardization; • Market factors; • Operational hurdles; • Poor supplier integration; • Regulation polices (bureaucracy); • Transferring manufacturing concepts into another industry • Uncertainties in demand; 	(Arkader and Janeiro, 2001; Deloitte and Touche, 2002; Hacker and Doolen, 2005; Radnor and Walley, 2008; Radnor and Boaden, 2008; Scorsone, 2008; Young and McClean, 2009; Radnor, 2010; Suárez-Barraza and Ramis-Pujol, 2010; Poksinska, 2010; Grove <i>et al.</i> , 2010; Wong and Wong, 2011; Eswaramoorthi <i>et al.</i> , 2011; Deflorin and Scherrer-Rathje, 2012a, 2012b; Machado Guimarães <i>et al.</i> , 2013; Jadhav, <i>et al.</i> , 2014; Rymaszewska, 2014; Dora <i>et al.</i> , 2014; Sisson and Elshennawy, 2015; Zimmermann and Bollbach, 2015; Matthias and Brown, 2016; Cherrafi <i>et al.</i> , 2016; Sahai, Virmani and Saha, 2017; Pearce <i>et al.</i> , 2018; Rexeisen <i>et al.</i> , 2018; Tezel <i>et al.</i> , 2018; Thanki and Thakkar, 2018; De Oliveira <i>et al.</i> , 2018; Yadav <i>et al.</i> , 2018; Caldera <i>et al.</i> , 2019; Isfahani <i>et al.</i> , 2019; Sindhwani <i>et al.</i> , 2019; Gao and Gurd, 2019)
Resources constraints	<ul style="list-style-type: none"> • Budget constraints; • Financial 	(Er <i>et al.</i> , 2000; Bateman and Rich, 2003; Canadian Manufactures and exporters, 2006; Radnor <i>et al.</i> , 2006; Lean

	constraints; <ul style="list-style-type: none"> • Funding constraints; • High cost; • Insufficient external funding; • Lack of equipment; • Lack of human resources; • Lack of internal funding; • Resources constraints; • Time availability; 	Enterprise Institute, 2007; Radnor, 2010; Bhasin, 2011; Eswaramoorthi <i>et al.</i> , 2011; Timans <i>et al.</i> , 2012; Bhasin, 2012, 2013; Vienažindienė and Čiarnienė, 2013; Albliwi <i>et al.</i> , 2014; Jadhav <i>et al.</i> , 2015; Marodin <i>et al.</i> , 2015; Sisson and Elshennawy, 2015; Mittal <i>et al.</i> , 2016; Jaiprakash Bhamu, 2016; Cherrafi <i>et al.</i> , 2016; Balzer <i>et al.</i> , 2016; Cherrafi <i>et al.</i> , 2017; Ainul Azyan <i>et al.</i> , 2017; Soliman and Saurin, 2017; Zhang <i>et al.</i> , 2017; Albliwi <i>et al.</i> , 2017; DeSanctis <i>et al.</i> , 2018; Edison <i>et al.</i> , 2018; Khaba and Bhar, 2018; Muraliraj <i>et al.</i> , 2018; Raval <i>et al.</i> , 2018; Sahoo and Yadav, 2018; Tiwari and Tiwari, 2018; Yadav <i>et al.</i> , 2018; Piyathanavong <i>et al.</i> , 2019; Caldera <i>et al.</i> , 2019)
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Table 2 – Thematic Analysis Frequency

Main Themes	Frequency
Behavioural and Cultural Influence	22.14%
Organisational Strategy and Alignment	21.84%
Technical Limitation	19.18%
Process-based	13.57%
Leadership Commitment	12.86%
Resources Constraints	10.41%