



LEAN THINKING IN DUTCH HOSPITALS

A case study approach

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Date:	14-1-2021

Abstract

Rapidly rising healthcare costs and increased attention towards patient safety have promoted awareness for process improvement initiatives in healthcare systems. To improve patient safety and financial performance, healthcare organisations have implemented process improvement techniques such as lean management. Many hospitals implement lean with the narrow view of eliminating waste and reducing costs or focus only on tools instead of on the philosophy or the way of thinking. To better realise the potential benefits of lean in hospitals, a holistic approach is necessary. This study aims to understand how lean thinking can be successfully implemented in Dutch hospitals to improve performance.

A qualitative case study research design was chosen, since the aim was to gain an in-depth understanding of lean thinking in Dutch hospitals. Semi-structured interviews were conducted with ten employees from seven hospitals and with a lean consultant from a consultancy firm. The interviews were conducted by phone or via online communication software Skype and Zoom. The data analysis was performed both within-case and cross-case.

This study revealed that, among the 16 lean tools and methods indicated within the interviews, value stream mapping was the most frequently mentioned, followed by team approach to problem solving and visual management. The results of this study indicate that lean tools and methods are applied with varying scopes. In some cases, the tools are applied only within the boundaries of a department. In other cases, they are applied across departments, through different layers of the hospitals, or even including processes outside the boundaries of the hospital. This study revealed that, among the 20 enabling factors of lean interventions indicated during the interviews, management support was the most frequently mentioned, followed by resources, supportive culture and training. This study also found that, among the 15 outcomes of lean interventions indicated during the interviews, job satisfaction was most the most frequently mentioned, followed by time savings.

These results suggest that to better realise the potential benefits of lean, such as increased job satisfaction and time savings, hospitals should focus on some important enabling factors when applying lean tools and methods. Most important is that the lean interventions are supported by managers at all levels in the organisation and that time and budget resources are made available so that employees have the opportunity to work on making process improvements. Furthermore, a supportive culture should be created, where the views, norms and beliefs within the hospital in relation to quality improvement are stimulated. Finally, training in lean principles, lean tools and methods, and leadership and change management should be provided to hospital employees and managers.

Preface

This thesis is written to fulfil the graduation requirements of the Supply Chain Management Master program of Tilburg University.

During my previous study, Logistics Management at Breda University of Applied Sciences, I was drawn to the healthcare environment, and specifically to the connection with logistics. During my bachelor's internship at a Dutch hospital, I experienced the complexity of the healthcare environment for the first time.

I became enthusiastic when I saw a thesis proposal written by Marianna Frangeskou, who also became my supervisor, regarding the adoption of operations management (OM) initiatives in healthcare settings. I came up with the idea to investigate lean thinking after reviewing the literature about OM initiatives in hospitals.

I would like to thank my supervisor Marianna Frangeskou for the support and valuable pieces of advice during my writing process. I also wish to explicitly thank all of the respondents, who provided me with lots of interesting insights. I want to thank my father, Jaap Limpers, for putting me in contact with the first interview respondents. Finally, I would like to thank my girlfriend, Jamilla Kaspers, for debating issues with me and for keeping me motivated.

Sander Limpers

Nijmegen, January 14, 2021

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Chapter 1: Introduction

1.1 Problem identification

Rapidly rising healthcare costs and increased attention towards patient safety have promoted awareness for process improvement initiatives in healthcare systems (Gowen, McFadden, and Settaluri, 2012; Boyer, Gardner, and Schweikhart, 2012). In 2019, expenditure on care and welfare in the Netherlands saw its highest growth rate since 2009. The amount from the previous year increased by 5.2% to 106.2 billion euros. Total healthcare spending – not including childcare, a portion of elderly care, and welfare – rose 4.8% to 80.9 billion euros (CBS, 2020). The National Institute for Public Health and the Environment (RIVM) released a report which stated that the care and welfare expenditure, which currently stands at 13.1%, will account for 19.6% in 2060 (RIVM, 2020).

Patient safety has received substantial attention from hospital executives and researchers since the publication of the Institute of Medicine (IOM) report, *To Err is Human*, in 1999 (Dobrzykowski, McFadden, and Vonderembse, 2016). The IOM report claims that medical errors are responsible for the death of about 98,000 hospitalised patients in the US annually (IOM, 2000). The Netherlands Institute for Health Services Research (NIVEL) published a report on patient safety in the Netherlands and found that there was a significant decrease in adverse events between 2011 and 2016, but preventable adverse events and potentially preventable deaths remained the same in this period (NIVEL, 2017). The report concludes that future research should examine more effective improvement possibilities since there was no further decrease in preventable adverse events and potentially preventable deaths.

To improve patient safety and financial performance, many healthcare organisations have implemented process improvement techniques such as lean management (Dobrzykowski et al., 2016). A critical component of lean is to provide value to the customers by delivering exactly what they want, on time, and with no defects, through the identification and elimination of waste (Mazzocato et al., 2010; Poksinska, 2010; Dobrzykowski et al., 2016). However, some authors are concerned with the effectiveness of lean (Garban, 2009) and have failed to find a significant relationship between process improvement and either customer satisfaction or financial performance (Douglas & Lawrence, 2004). Many hospitals implement lean with the narrow view of eliminating waste and reducing costs (Dahlgaard, Pettersen, & Dahlgaard-Park, 2011) or focus only on tools instead of on the philosophy or the way of thinking (Akmal et al., 2020; Mazzocato et al., 2010; D'Andreamatteoa et al., 2015). To better realise the potential benefits of lean in hospitals, a holistic approach is necessary (Mazzocato, Savage, Brommels, Aronsson, & Thor, 2010; Holden, 2011; Poksinska, 2010; D'Andreamatteoa et al., 2015).

Process improvement initiatives such as lean in healthcare are incredibly complex (Flynn and Hartfield, 2016). These initiatives can result in a variety of patient-, process-, or system-level outcomes, since they consist of interacting components that target different levels of the organisation and require behavioural changes from those delivering or receiving the process improvement initiative (Craig, et al., 2013).

Flynn and Hartfield (2016) argue that, based on a review of the literature, there is no ‘magic bullet’ to ensure successful quality improvement initiatives in the complex environment of healthcare. However, understanding the barriers to and facilitators of process improvement initiatives can lead to more efficient and effective implementation across healthcare settings (Cochrane, et al., 2007). Andersen et al. (2014) note that the literature regarding lean implementation in healthcare lacks a specification of when and how the different facilitators work.

In response to this research gap, the present study aims to understand how lean thinking can be successfully implemented in Dutch hospitals to improve performance. This will provide hospitals with insight into how the potential benefits of lean thinking can be better realised.

1.2 Research questions

Based on this problem indication, the main research question of this research is as follows:

How can lean thinking be successfully implemented in Dutch hospitals to improve performance?

To answer this main research question, the following research sub-questions have been formulated:

Theoretical research questions:

1. How is lean thinking applied in hospitals?
2. Which factors enable the successful implementation of lean thinking in hospitals?
3. What are the outcomes of lean interventions in hospitals?

Practical research questions:

1. How is lean thinking applied in Dutch hospitals?
2. Which factors enable the successful implementation of lean thinking in Dutch hospitals?
3. What are the outcomes of lean interventions in Dutch hospitals?

1.3 Structure of thesis

This thesis consists of six chapters. Chapter 2 discusses the relevant literature concerning the application of lean management in hospitals and the factors that enable lean interventions. Subsequently, the outcomes of lean interventions in hospitals are discussed. At the end of the theoretical framework, a conceptual model is presented. Chapter 3 addresses the methodology of this study, including the research design and the validity and reliability of the research. In Chapter 4, the findings of this study are presented, followed by a revised conceptual model. The findings are then discussed in Chapter 5. Additionally, the limitations of this study are discussed, and recommendations for future research are provided. Finally, Chapter 7 presents the conclusion.

Chapter 2: Theoretical Framework

The theoretical framework is divided into three separate sections, each addressing one research question. The focus of the first part is on literature related to how lean thinking is applied in hospitals. The second part focuses on literature regarding enabling factors of lean interventions in hospitals. The last part is focused on the outcomes of lean interventions in hospitals. For this research, the databases EBSCOhost and Google Scholar were used. The keywords identified in Table 1 were used to search for articles, and Google Scholar was used when the full text of a certain article was not available in EBSCOhost. The keywords were only searched for in the abstract field. This way, literature that did not focus on the research topic would be excluded (Saunders & Lewis, 2018). Furthermore, articles that were not written in English or that mentioned a hybrid improvement approach in the abstract, such as Lean Six Sigma, were also excluded. The reference lists of papers in the final sample were used to search for additional relevant papers.

Table 1 Literature search overview

Area	Initial keywords	Papers	Inclusion criteria	Final sample
Lean thinking in hospitals and the outcomes	“Lean thinking” AND “improvement” AND “hospital”	61	(1) Research focus on hospitals (2) Main focus on application of lean in hospitals and outcomes	22
Enabling factors of lean interventions in hospitals	“Lean thinking” AND “improvement” AND “hospital” AND “implementation”	17	(1) Research focus on hospitals (2) Main focus on factors enabling the implementation of lean	9

2.1 How is lean thinking applied in hospitals?

In this section, relevant literature related to the application of lean in hospitals is discussed. First, a brief description is given of the background of lean thinking. Second, the scope of lean implementation in hospitals is discussed. Finally, an explanation of lean tools and methods used in hospitals is provided.

2.1.1 Lean thinking background

The term ‘lean thinking’ stems from the production philosophy at Toyota called the Toyota Production System (Womack & Jones, 1996; Gao & Gurd, 2019). The seven wastes of lean found in production are also present in hospital operations. These include, for example, the transport of patients (transport), materials not being used in storage (inventory), movement of staff looking for documents (motion), patient waiting in lines (waiting), duplicate work (overproduction), duplication of information (overprocessing), and incorrect prescription (defects) (Régis, Santos, & Gohr, 2019). Lean thinking is often described as a quality improvement philosophy that consists of a bundle of concepts, methods, and tools (Vashi, Lerner, Urech, Asch, & Charns, 2019; Holden, 2011). Womack and Jones (1996) were among the first to propose the use of lean thinking in the service industry, specifically in healthcare (Dobrzykowski et al., 2016).

Womack and Jones (1996) define five lean principles:

- Define value: value from the end customers' perspective
- Identify the value stream: eliminate unnecessary waste
- Create flow: achieve a smooth and continuous flow of work
- Establish pull: let the customer pull the product from you
- Seek perfection: strive for continuous improvement

2.1.2 Scope of lean implementation in hospitals

Many authors agree on the issue that lean is implemented with a limited scope and that it often focuses on just a single department or function, rather than on a whole system (Akmal et al., 2020; Mazzocato et al., 2010). This silo mentality is deeply rooted in healthcare practice and managerial thinking (Akmal et al., 2020). A recent study by Akmal et al. (2020) reviewed 299 studies, of which 103 empirical articles used a case study approach describing lean thinking implementation in healthcare organisations and 196 articles focused on healthcare supply chain management. They found that only 13 out of the 103 cases considered a systemwide approach. Similarly, Poksinska (2010) states that many healthcare units work in silos and that they are often unaware of the effects their work has outside their department. Poksinska concludes that problems often occur in the crossing between departments and units. Lean thinking is used in a wide range of organisational settings, clinical specialities, and healthcare fields (Akmal et al., 2020; Mazzocato et al., 2010; D'Andreamattea et al., 2015; Poksinska 2010). Mazzocato et al. (2010) identified various hospital settings in which lean thinking is used, such as diagnostics units, hospital departments, and hospital in-patient care units. They also identified applications of lean in multiple healthcare fields, such as clinical specialties (emergency medicine, intensive care, surgery, etc.) and diagnostics services (pathology, radiology, etc.). Similarly, Akmal et al. (2020) identified various departments and functions in which lean thinking initiatives are implemented. They demonstrate that lean is most used in the emergency department, followed by cancer care, surgery and medical records administration.

Implementation of lean is often focused on tools instead of on the philosophy or the way of thinking (Akmal et al., 2020; Mazzocato et al., 2010; D'Andreamattea et al., 2015). Akmal et al. (2020) conclude that instead of a focus on tools, organisations should create a lean culture to implement lean thinking. They argue that when lean is only based on tools, it does not provide a better value proposition to the organisation and that this part has often been ignored in the studies they reviewed. Similarly, Mazzocato et al. (2010) found that most organisations they studied limited themselves to implementing specific lean techniques to solve problems in a single department or unit. They mention, however, that tools and methods are important for the effectiveness of lean thinking in healthcare but that the learning capabilities based on problem identification, problem solving and solution retention are even more important. Akmal et al. (2020) note that it can be difficult to distinguish organisations that implement

lean with a focus only on tools from organisations that use a systemwide approach. They identify four elements of lean to distinguish tool-focused implementation from a systemwide approach:

- Viewed as a long-term journey
- Continuous improvement framework at its core
- Implemented with multiple tools and techniques simultaneously
- Based on cultural changes that promote employee empowerment and waste elimination throughout the entire value chain

Other authors emphasise similar elements of lean implementation as a systemwide approach (Régis, Santos, & Gohr, 2019). For instance, Régis et al. (2019) mention that when a systemic approach is taken, the lean principles can be reached by using lean tools and that, this way, benefits will be more sustainable in the long term. They found that a continuous improvement framework, such as plan-do-check-act (PDCA), ensures that lean remains a part of the daily routine in healthcare. Similarly, Mazzocato et al. (2010) emphasise that lean should be a long-term philosophy and that quality improvement should become everyone's responsibility in organisations.

2.1.3 Lean tools and methods used in hospitals

Many authors have identified similar lean tools and methods that have been implemented in hospitals (Gao & Gurd, 2019; Mazzocato et al., 2010; Akmal et al., 2020; Poksinska, 2010). Mazzocato et al. (2010) divided the lean tools and methods used in the articles they examined into four categories which they call components of lean thinking. These components trigger a mechanism, such as shared understanding or practical suggestions for how to organise and design workflows, which generates an outcome. Figure 1 displays these four components of lean thinking with corresponding methods and tools based on the distinction made by Mazzocato et al. (2010). These components include methods to understand processes in order to identify and analyse problems; methods to organise more effective and/or efficient processes; methods to improve error detection, relay information to problem solvers, and prevent errors from causing harm; and methods to manage change and solve problems with a scientific approach. In the subsequent sections, lean tools and methods included in these components are discussed.

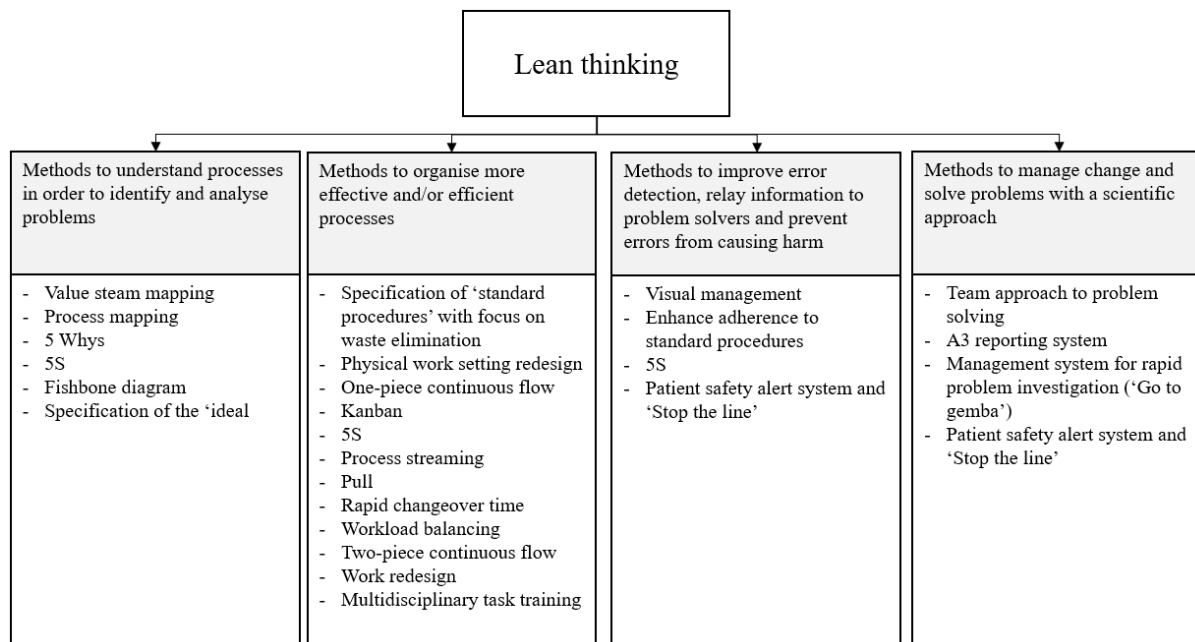


Figure 1 Lean thinking in hospitals

2.1.3.1 Methods to understand processes in order to identify and analyse problems

The tools and methods in the first component are used to identify and analyse problems, which generates shared understanding (Mazzocato et al., 2010). These include methods such as value stream mapping (VSM), process mapping, 5 whys, 5S, fishbone diagram and specification of the 'ideal' (Mazzocato et al., 2010). Value stream mapping and process mapping are important tools to identify opportunities to reduce waste and improve processing efficiency (Improta, et al., 2018). Akmal et al. (2020) found that in the studies they reviewed, VSM, 5S, and fishbone diagram were the most used lean tools in healthcare to understand processes. Similarly, Gao & Gurd (2019) found that 5S was the most frequently used lean method among 127 Chinese hospitals, followed by VSM. 5S is a method for organising and standardising workspaces and consists of five stages: sort, set in order, shine, standardise, and sustain (Holden, 2011). The 5 whys method is used to identify the root cause of a problem (Condel & Sharbaugh, 2004). Another method used for identifying and analysing problems is specifying the ideal (Mazzocato et al., 2010). Braaten and Bellhouse (2007), for instance, describe ideal patient care as providing exactly what the patient needs, when and where he/she needs it; immediate response; no wasted resources; individually customised; and safe. This method can be useful for staff to determine whether the conditions are met (Braaten & Bellhouse, 2007).

2.1.3.2 Methods to organise more effective and/or efficient processes

In the second component, tools and methods are used to generate practical suggestions for how to organise works flows and the work environment to improve efficiency and effectiveness (Mazzocato et al., 2010). These include methods such as specification of 'standard procedures', physical work setting redesign, one-piece continuous flow, Kanban, 5S, process streaming, pull, rapid changeover time,

workload balancing, two-piece continuous flow, work redesign, and multidisciplinary task training (Mazzocato et al., 2010). Leslie, Hagood, Royer, Reece, and Maloney (2006) used the lean tools standard work and rapid changeover time to improve operating room turnover performance. Standardised work is based on the assessment of what the presumed “best way” to do the work is (Holden, 2011). Furthermore, Nelson-Peterson and Leppa (2007) used one-piece flow to complete all aspects of work with one patient before moving to the next patient, and they used a Kanban system to ensure that the supplies were replenished just in time. Standard procedures were used to make process steps repeatable so that they could be done in the same way by the staff (Nelson-Peterson & Leppa, 2007). Lummus et al. (2006) propose the use of a pull system in the form of a scheduling plan to ensure a steady flow of patients. Finally, multidisciplinary training was used by Shannon et al. (2006) to improve the training in central line placement.

2.1.3.3 Methods to improve error detection, relay information to problem solvers and prevent errors from causing harm

Methods and tools in the third component are used to improve process reliability by improving error detection and making the work clearer and the staff more aware of how work should be done. These include methods such as visual management, enhanced adherence to standard procedures, 5S, a patient safety alert system and ‘stop the line’ (Mazzocato et al., 2010). Furman and Caplan (2007) used visual management by putting name tags on drawers to indicate where products were stored. They also gave patients a coloured wristband to indicate special conditions such as allergies. The ‘stop the line’ method stems from the idea of using lean to pursue zero defects by finding and fixing mistakes as soon as possible (Furman & Caplan, 2007). In manufacturing, this is used when employees encounter a problem that cannot be fixed in the specified time, so he or she stops the production process (Furman & Caplan, 2007). In healthcare, this method is called the Patient Safety Alert (PSA) system and is used, for instance, in a situation in which a cardiac arrest occurs, then employees stop with their current tasks to assist and bring the necessary resources (Furman & Caplan, 2007).

2.1.3.4 Methods to manage change and solve problems with a scientific approach

In the fourth component, methods and tools are used to manage change and solve problems with a scientific approach to create a shared understanding of a problem and how it can be solved. They can also contribute to a culture of continuous improvement. These include methods such as a team approach to problem solving, A3 reporting system, management system for rapid problem investigation (‘go to gemba’), the PSA system and ‘stop the line’ (Mazzocato et al., 2010). The A3 reporting system is a rigorous and systematic approach for solving problems (Jimmerson, Weber, & Sobek, 2005). It breaks problems down into smaller parts so that workers can rapidly identify improvement opportunities. Jimmerson et al. (2005) used A3 reporting in combination with VSM to study particular problem areas that were identified in the VSM. Thompson, Wolf, and Spear (2003) propose the use of what they call

‘learning lines’ as a management system for rapid problem investigation. This involves forming small groups from a horizontal slice of the organisation to encounter problems, give rapid feedback, and test changes in work that will remove the root cause of the problem and thereby improve the process.

2.2 Which factors enable the successful implementation of lean thinking in hospitals?

In this section, relevant literature related to enabling factors of lean interventions in hospitals is discussed.

Process improvement initiatives in healthcare, such as lean thinking, are incredibly complex (Flynn and Hartfield, 2016). Flynn and Hartfield (2016) argue that there is no ‘magic bullet’ to ensure successful quality improvement initiatives in the complex environment of healthcare. However, understanding the barriers to and facilitators of process improvement initiatives can lead to more efficient and effective implementation across healthcare settings (Cochrane, et al., 2007). The literature on lean thinking in healthcare often discusses similar factors that contribute to successful implementation (Andersen, Røvik, and Ingebrigtsen, 2014; D’Andreamatteoa et al., 2015; Poksinska, 2010). Through a systematic review of the literature regarding quality improvement in hospitals, Andersen et al. (2014) identified 23 enabling factors of successful lean interventions. They note that the literature they reviewed regarding lean implementation in healthcare lacks a specification of when and how the different facilitators work. Therefore, they propose a framework for the identification and analysis of facilitators of lean interventions in healthcare. Figure 2 depicts the four dimensions of the enabling factors of lean interventions in hospitals based on the distinction made by Andersen et al. (2014). These four dimensions include the situation, organisation or setting in which the interventions are deployed; the characteristics of the interventions; the process through which the interventions are delivered; and sustained improvement in the organisation over the long term. In the following sections, enabling factors included in these dimensions are discussed.

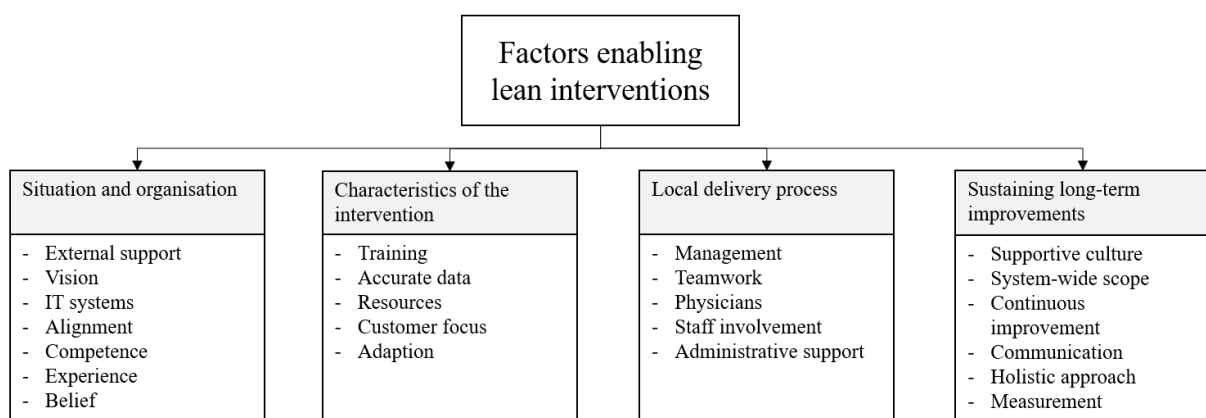


Figure 2 Factors enabling lean interventions

2.2.1 Situation and organisation

The first dimension consists of enabling factors that relate to the situation, organisation or setting in which the interventions are deployed. Régis et al. (2019) mention that it is vital for hospitals to hire a consultant company if no internal team is available to manage the process implementation. Similarly, D'Andreamatteo et al. (2015) note that it can be useful to hire external change agencies to improve the connection between the intervention and the workers. The goals of the lean interventions should be of strategic importance while, at the same time, being realistic and based on simple and practical solutions (Andersen et al., 2014). Likewise, D'Andreamatteo et al. (2015) mention that a clear definition of quality targets, such as patient safety or economic performance, is crucial. There should be adequate IT support available and adequate infrastructure in place (Andersen et al., 2014). The targets of the lean interventions should be aligned with the strategic objectives of the hospital (Andersen et al., 2014), and there should be links between implementation attempts and the improvement strategy (D'Andreamatteo et al., 2015). Employees should have the competence with tools and methods to be able to take initiative and make improvements (Andersen et al., 2014; D'Andreamatteo et al., 2015). Learning from prior experience (D'Andreamatteo et al., 2015) and sharing success stories related to the benefits for both patients and staff can contribute to the success of the interventions (Andersen et al., 2014). Employees must be motivated to improve their work (Holden, 2011). Management can encourage motivation and willingness by believing in the employees (Andersen et al., 2014). In addition, D'Andreamatteo et al. (2015) assert that, to encourage greater involvement, rewards and incentives should be provided.

2.2.2 Characteristics of the intervention

The second dimension consists of enabling factors that relate to the characteristics of the interventions. The importance of training in lean methods and tools is frequently mentioned as an enabler of lean interventions (Andersen et al., 2014; D'Andreamatteo et al., 2015; Poksinska, 2010). Similarly, Régis et al. (2019) argue that the use of external experts is not enough to achieve successful lean implementation and that the workforce should also be trained. Through these trainings, employees can also create a new way of thinking about their work, where they feel that they can take initiative and utilise their skills and creativity to make thinking happen (Poksinska, 2010). The availability of accurate data is essential to the success of lean (D'Andreamatteo et al., 2015). In addition, Andersen et al. (2014) state that timely data contributes to evidence-based lean interventions. Resource allocation in terms of staff time, as well as budget, is also important for lean to succeed (Andersen et al., 2014). Likewise, Holden (2011) mentions that these resources are necessary to do a thorough job. When applying lean in hospitals, emphasis should be placed on the understanding of the patients' needs and what they value (Andersen et al., 2014; D'Andreamatteo et al., 2015). The lean interventions should be adapted to the local context and demographic environment (D'Andreamatteo et al., 2015; Holden, 2011). Andersen et al. (2014) note that this translation is a prerequisite for the intervention to be successful.

2.2.3 Local delivery process

The third dimension consists of enabling factors that relate to the process through which the interventions are delivered. Support from managers at all levels is an important factor of successful lean implementation (Akmal et al., 2020; Holden, 2011; Poksinska, 2010). Poksinska (2010) asserts that, for top-level managers, it is important to display genuine interest in the implementation and to provide the necessary resources. Lower-level management, then, need to take ownership of the change and should actively support their employees in the improvement process. Similar results were found by Andersen et al. (2014), who discovered that management support was the most frequently mentioned enabler in the articles they reviewed. Similarly, teamwork was often mentioned as an important factor in the success of lean (Andersen et al., 2014). They additionally found that working in multidisciplinary and multiskilled teams facilitates the local application of lean (Andersen et al., 2014; Holden, 2011). The involvement and engagement of physicians is also seen as an important factor in the successful application of lean (Andersen et al., 2014). Commitment and participation of healthcare staff is essential, since they are the experts in their work, and they contribute their knowledge, experience and skills by getting involved (Holden, 2011; Poksinska, 2010). Administrative support can also contribute to the success of lean interventions, for instance, by tracking employees' suggestions for change (Holden, 2011) and through administrative project management (Andersen et al., 2014).

2.2.4 Sustaining long-term improvements

The last dimension consists of enabling factors that relate to sustaining the improvements in the organisation over the long term. A supportive culture in terms of the views, norms and beliefs within the hospital that support quality improvement is a significant enabler. Andersen et al. (2014) conclude that this was the second most frequently mentioned enabler in the studies they reviewed. This has also been identified as a key enabler by other authors (Akmal et al., 2020; D'Andreamattea et al., 2015; Poksinska, 2010). The lean interventions should have a systemwide approach, spanning across different functions and departments, to allow best practices to be learned throughout the hospital (Andersen et al., 2014). Similarly, Holden (2011) mentions that employees from different hospital units can learn from each other by sharing the lessons they have learned. For a successful lean intervention, it is crucial to foster a long-term view of continuous improvement (Andersen et al., 2014; D'Andreamattea et al., 2015). Holden (2011) suggests that plans should be made to sustain the lean interventions and to continuously evaluate them, as well as that previous changes should be adjusted and further changes planned. Communication with and between patients and staff, including feedback and suggestions for change, is another important factor (Andersen et al., 2014; Holden, 2011). Lean should be perceived as a philosophy that stimulates continuous quality improvement within the value system of the hospital and not just as a way to promote everyday change. Similarly, D'Andreamattea et al. (2015) mention that lean should be seen as part of a larger management shift towards changing the workplace and the mindset of employees. D'Andreamattea et al. (2015) suggest that, in some instances, healthcare organisations

can apply key performance indicators from an industrial setting to measure change in the healthcare context. These measurements can provide evidence of success for future lean interventions if done regularly (Andersen et al., 2014).

2.3 What are the outcomes of lean interventions in hospitals?

In this section, the relevant literature related outcomes of lean interventions in hospitals is discussed. Many authors have described different areas in which lean has had a positive impact on the performance of healthcare (Akmal et al., 2020; Mazzocato et al., 2010; D’Andreamatteoa et al., 2015; Poksinska, 2010). All the articles reviewed by Mazzocato et al. (2010) report positive results of lean applications. However, they suspect a publication bias – in their opinion, there are surely some failed lean applications that have not yet been studied. Similarly, D’Andreamatteoa et al. (2015) mention that almost no negative effects were reported in the cases they reviewed. They found only one case reporting a failed attempt at a lean implementation. In this case, lean was implemented in an emergency department to reduce throughput time and increase patient satisfaction. In the first two years after this lean implementation, there was no improvement in length of stay and patient satisfaction (Dickson, Anguelov, Vetterick, Eller, & Singh, 2009). Similarly, in a more recent study, Po, Rundall, Shortell, and Blodgett (2019) failed to find a significant association between lean implementation and patient outcome or patient satisfaction measures.

Poksinska (2010) mentions that there is a lack of rigorous research on the outcomes of lean in healthcare because the studies are often not comparative and include mainly self-reported results. Similarly, Akmal et al. (2020) conclude that the effectiveness of lean thinking in healthcare operations is often mentioned in the literature, however, it remains questioned due to a lack of strong evaluation of the implementations.

Outcomes of lean thinking can be divided into two broad areas: one relates to hospital performance, while the other relates to the development of employees and the work environment (Poksinska, 2010; Mazzocato et al., 2010). Figure 3 illustrates the two dimensions of outcomes of lean thinking based on the distinction made by Poksinska (2010). This distinction in outcomes of lean thinking is elaborated in the following sections.

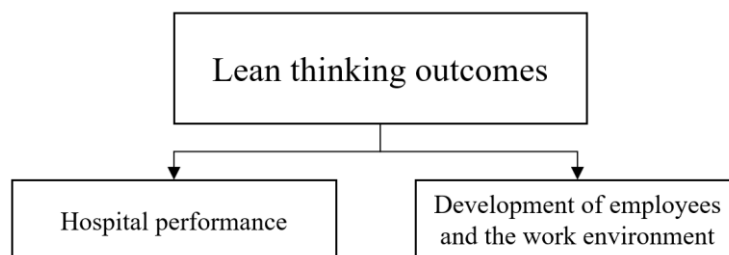


Figure 3 Lean thinking outcomes

2.3.1 Hospital performance

The first area relates to more tangible outcomes, such as increased patient throughput and time savings (Poksinska, 2010). The outcomes in performance are measurable and can be described in numbers or as improvement rates. Overall, the most frequently mentioned performance outcomes are time savings, increased patient throughput, increased productivity, patient safety, and quality aspects such as reduction of errors and mistakes (Akmal et al., 2020; Mazzocato et al., 2010; D'Andreamatteoa et al., 2015; Poksinska, 2010).

2.3.2 Development of employees and the work environment

The second area relates to more intangible outcomes such as increased employee attention towards waste in the processes and a proactive attitude towards problem solving (Poksinska, 2010). The outcomes related to the development of employees and the work environment are often qualitative. Frequently mentioned outcomes in this area include, for instance, increased process understanding, staff engagement and willingness to collaborate, a proactive attitude regarding identifying waste and problem solving, and a calmer and more focused working environment (Poksinska, 2010; Mazzocato et al., 2010).

2.4 Conceptual model

Based on the previous literature review, the conceptual model can be constructed as shown in Figure 4. It has become clear that the dependent variable, performance, is influenced by the independent variable, lean thinking implementation, and that this relationship is affected by the moderating variable, enabling factors of lean interventions.

Lean thinking implementation is split into four dimensions, each consisting of several subvariables, as described in Section 2.1.3. The enabling factors of lean interventions are also split into four dimensions, each consisting of several subvariables, as described in Section 2.2. Performance is split into two dimensions, each consisting of several subvariables, as described in Section 2.3.

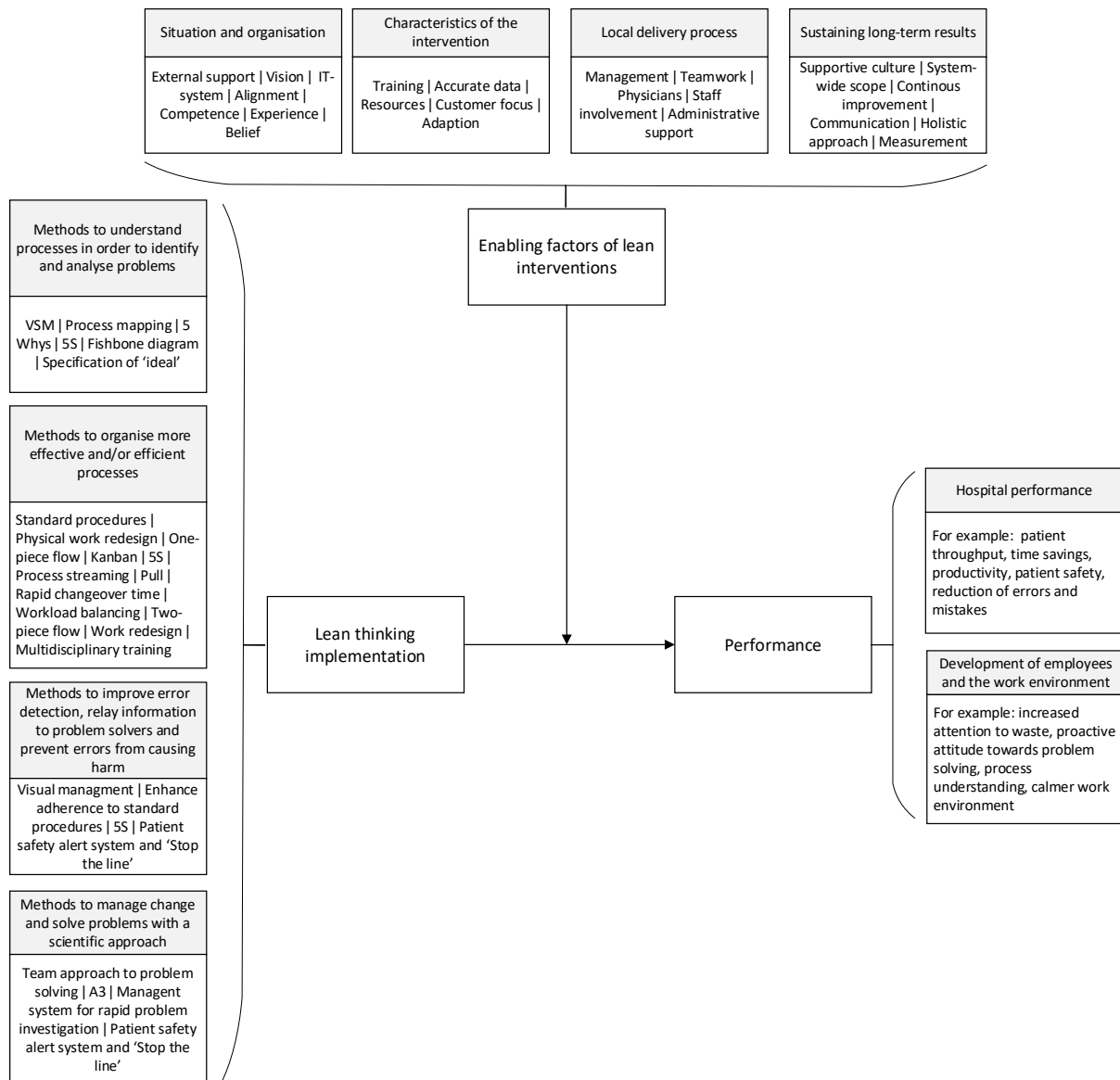


Figure 4 Conceptual model

Chapter 3: Methodology

This chapter describes the research design and discusses the validity and reliability of the research.

3.1 Research objective

This study aims to understand how lean thinking can be successfully implemented in Dutch hospitals to improve performance. This will provide hospitals with insight into how the potential benefits of lean thinking can be better realised.

3.2 Research strategy

A qualitative case study research design was chosen to answer the practical research questions, since the aim was to gain an in-depth understanding of lean thinking in Dutch hospitals. Qualitative data can be used to obtain insight into complex social processes in a complex context (Eisenhardt & Graebner, 2007). Therefore, the use of qualitative data seemed to fit the aim of this study, since quality improvement initiatives are often referred to as complex social interventions (Mazzocato et al., 2010) and the healthcare context is frequently considered complex (Akmal et al., 2020; D'Andreamattea et al., 2015). A case study was a suitable strategy for this research since case studies enable the researcher to gain a detailed understanding of the context of the research and the activities taking place within that context (Saunders & Lewis, 2012).

3.3 Sampling design

To gain insight into the lean thinking experiences of Dutch hospitals, semi-structured interviews were conducted with employees from seven hospitals. The nonprobability sampling technique 'purposive sampling' was used to select these Dutch hospitals. More specifically, heterogeneous sampling was used to select both academic/non-academic general hospitals and a specialised hospital. To identify interview participants at these hospitals, a snowball sampling technique was used. The first participants were contacted by phone or by email through networks of the researchers' relatives. Employees were approached based on their profession within the hospitals. After the first three interviews, a participant suggested contacting a coordinator of the network of lean in healthcare (Lidz). Interview participants from hospitals four, five, six and seven volunteered to take part in the research as a response to the interview request sent via email within the Lidz network. The interviews were conducted with quality coordinators, lean coaches, and managers of the hospitals.

In addition to the interviews with hospital employees, one interview was conducted through the network of the researcher with a former lean advisor of a hospital who currently works as a lean consultant at a consultancy firm.

3.4 Data collection

The semi-structured interviews were conducted by phone or via online communication software Skype and Zoom. The main advantage of using videoconferencing software is that the researcher can observe nonverbal cues and gestures, which is not the case for telephone interviews. Nevertheless, a key disadvantage of both videoconferencing and phone interviews is that respondents could terminate the interview at any point without explanation (Sekaran & Bougie, 2016). All participants consented to a recording of the interview and the use of anonymised quotations in the report. An example of a consent form is given in Appendix 1. An interview guide was used for the interviews, which consisted of 13 questions (see Appendix 2). In Appendix 3, an English version of the interview guide is given. Since the examined concepts are rather abstract, they first needed to be operationalised to be measurable. This was done by looking at the dimensions of the concept and then translating these dimensions into measurable elements (Sekaran & Bougie, 2016). The first part of the interview consisted of questions related to how lean thinking is applied in hospitals. For these questions, the distinction made between the four components of lean thinking composed of different methods and tools as discussed in the theoretical framework was used. The second part of the interview consisted of questions related to the outcomes of lean thinking in hospitals in terms of hospital performance and the development of employees and the work environment. The last part consisted of questions related to the factors that enable the success of lean interventions. Table 2 provides an overview of the details of the respondents.

Table 2 Details of interviewees

Respondent	Organisation	Hospital type	Profession	Method
Respondent 1	Hospital 6	General	Quality advisor	Zoom
Respondent 2	Hospital 7	Specialised	Business manager	Zoom
Respondent 3	Hospital 7	Specialised	Lean coach	Zoom
Respondent 4	Consultancy firm	-	Lean consultant	Phone
Respondent 5	Hospital 1	Academic	Quality advisor	Skype
Respondent 6	Hospital 2	General	Program coordinator	Zoom
Respondent 7	Hospital 3	General	Lean manager	Zoom
Respondent 8	Hospital 4	General	Lean coach	Zoom
Respondent 9	Hospital 4	General	Lean coach	Zoom
Respondent 10	Hospital 1	Academic	Manager quality advisors	Phone
Respondent 11	Hospital 5	General	Program manager lean/ manager quality	Skype

3.5 Data analysis

Once the interviews were transcribed, the data were analysed. The transcriptions of the interviews are provided in Appendix 4. The data analysis was performed both within-case and cross-case. The idea of within-case analysis is to become familiar with each case and to investigate unique patterns before attempting to generalise patterns across cases (Eisenhardt K. M., 1989). The within-case analysis was used to analyse how lean thinking was applied in the case hospitals, what the outcomes of those lean interventions were, and which factors enabled them. In the cross-case analysis, the insights from the

within-case analysis were used to gain further insight into the data. First, the most frequently mentioned lean tools and methods used in the case hospitals were identified. Second, the most important enabling factors were determined. Finally, the most frequently mentioned outcomes were identified.

The general approach to analysing qualitative data consists of three steps: data reduction, data display and drawing conclusions (Sekaran & Bougie, 2016). The first step of the analysis was to reduce the data through coding and categorisation. The theoretical framework was used to construct a list of codes and categories, which are listed in Appendix 5. The data were coded using the literature as a direct source of codes and ideas (Locke, Feldman, & Golden-Biddle, 2020).

On the one hand, the literature was used as a direct source of codes to organise the data related to the application of lean in hospitals and the enabling factors of lean interventions. The 26 lean tools and methods identified by Mazzocato et al. (2010) were used to code the data regarding how lean is applied in hospitals. However, new codes were made when lean tools that were not identified in the literature review were mentioned. The coding scheme with this data is given in Appendix 6. The 23 enabling factors of lean interventions identified by Andersen et al. (2014) were used to code the data regarding the factors that enable lean interventions in hospitals. The coding scheme with this data is provided in Appendix 7.

On the other hand, the literature was used as a source of ideas to code the data related to the outcomes of lean interventions. The two main categories identified by Poksinska (2010) were used to create codes and recognise patterns in the data regarding the outcomes of lean interventions in hospitals. In Appendix 8, the coding scheme with this data is given. Table 3 illustrates an example of the data analysis conducted for one of the interviews. All of the respondents' quotations used in this research have been translated by the researcher from the interview transcripts.

3.6 Validity and reliability

The internal validity of the research has been enhanced in various ways. First, a structured interview guide was used to ask the respondents questions. The interview guide consisted of questions related to each of the variables under study. The questions for each variable were based on categories identified in high-quality articles (Mazzocato et al., 2010; Andersen et al., 2014; Poksinska 2010). The researcher asked follow-up questions if respondents did not completely understand a question. Second, the researcher tried to collect data from multiple cases of each hospital type. Ultimately, data were collected from six general hospitals, one academic hospital, and one specialised hospital. In addition, data were collected from one consultancy firm. The varying characteristics of the hospitals enriched the data gathered through case studies, which improved the validity of this research (Yin, 2013).

The external validity of this study was improved through the inclusion of more than one case study, which made the results more generalisable (Saunders & Lewis, 2012). However, the generalisability could be further enhanced if more cases of each hospital type were examined.

The reliability of the research was enhanced in multiple ways. First, the researcher reduced random errors by ensuring that respondents knew the topic. Second, the repeatability of the research was improved by providing a detailed description of the research approach and by providing the complete interview transcripts in the appendix. Lastly, the researcher tried to collect and analyse all of the data in a similar way. Each respondent was sent a letter explaining the purpose of the research and some general information about the interview. Furthermore, each respondent had the opportunity to choose the most convenient time, place and method (phone or online communication software) to participate in the interview.

Table 3 Coding example from interview with Respondent 7

Key concepts	Dimensions	Elements	Codes	Quotes (translated)
Lean thinking implementation (LI)	Methods to understand processes (MU)	VSM (VSM)	(LI-MU-VSM)	We use the value stream map, but they are used to understand where the bottlenecks are.
	Methods to organise processes (MO)	5S (FS)	(LI-MO-FS)	Quite a lot of 5S is used in the departments.
Enabling factors of lean interventions (EFL)	Situation and organisation (SO)	Vision (VI)	(EFL-SO-VI)	A clear strategy is desirable because you will notice that people will increasingly notice waste and potential improvements. [...] without a clear strategy you have no clear framework to make these decisions. [...] then everybody starts thinking about what they think is best and you still end up with siloes.
	Local delivery process (LDP)	Management (MA)	(EFL-LDP-MA)	I think that support from management is most important. [...] they need to stimulate [...] you need to have a pool that actively asks questions about the status of projects.
Lean thinking outcomes (LO)	Hospital performance (HP)	Throughput time reduction (TTR)	(LO-HP-TTR)	Or about throughput time [...] how long does it take from the first visit of the physician until the first diagnosis, and can we decrease that.
	Development of employees and the work environment (DEW)	Job satisfaction (JS)	(LO-DEW-JS)	The biggest motivation for people to work in healthcare is to deliver quality to patients. So, you notice that actually everything you do related to this motivates employees. They enjoy their work more because the care is improved.

Chapter 4: Findings

In this chapter, the findings from the interviews are presented. First, a brief description is given of the cases examined in this research. Second, the findings related to how lean was applied in the case hospitals are given. Third, the findings related to the enabling factors of successful lean interventions are presented. Finally, the findings related to the outcomes of the lean interventions in the case hospitals are given. For each finding one or two key quotations are given with corresponding function, case number and letter of the respondent.

4.1 Case description

In this research, eight individual cases were examined by the researcher. The first case hospital was the only academic hospital in this research. Case hospitals 2, 3, 4, 5 and 6 were general hospitals, while case hospital 7 was a specialised hospital. Case 8 was a consultancy firm. The respondent from this firm was a former employee of a general hospital who had worked for more than 10 years in the role of lean advisor. Six out of 7 case hospitals were part of the Lean in Healthcare (Lidz) network. This knowledge network is an independent foundation for healthcare institutions that apply lean principles within their organisation. Currently, 62 healthcare institutions are part of this network (Lidz, 2020). Table 4 provides an overview of the cases examined in this research. For each case, the following information is given: hospital type, size of the hospital based on the number of beds, annual day treatments, annual admission, and participation in the Lidz network. This information can be found on hospital websites or publicly available websites (Ziekenhuischeck, 2020). For this research, the following definition of hospital size is used (Slyter, 2018):

- Small hospitals contain fewer than 100 beds
- Medium hospitals contain 100 to 499 beds
- Large hospitals contain 500 or more beds

Table 4 Overview of cases

Case	Hospital type	Size (number of beds)	Day treatments (annually)	Admissions (annually)	Lidz
1	Academic	Large	25,000 to 30,000	25,000 to 30,000	Yes
2	General	Medium	25,000 to 30,000	20,000 to 25,000	Yes
3	General	Large	20,000 to 25,000	35,000 to 40,000	Yes
4	General	Medium	5,000 to 10,000	10,000 to 15,000	Yes
5	General	Medium	25,000 to 30,000	20,000 to 25,000	Yes
6	General	Medium	20,000 to 25,000	20,000 to 25,000	No
7	Specialised	Medium	Less than 5,000	Less than 5,000	Yes
8	Consultancy firm	-	-	-	-

4.2 Lean thinking implementation

In this section, the findings related to the implementation of lean thinking in the case hospitals are presented. The complete coding scheme regarding these findings is given in Appendix 6.

4.2.1 Methods to understand processes in order to identify and analyse problems

Value stream mapping (VSM) was the most frequently mentioned lean method used in the hospital to understand the process in order to identify and analyse problems. Additionally, the methods fishbone diagram and specification of the ‘ideal’ were mentioned twice. Ohno circle and 5 whys were only mentioned once; thus, they are only shown in Appendix 6.

As previously stated, overall, VSM was the most mentioned tool in the interviews. Ten out of 11 respondents mentioned that VSM was used in their hospital to understand the process and identify opportunities for improvement. They approached the value stream map in various ways based on the goal they wanted to reach and the process they wanted to improve.

Manager quality advisors (1B) stated the following: *The big method that we use is the value stream map. [...] we do that almost always when there is an existing process that needs to be improved. [...] we use that rather standardised, and then we map the process with a big group of employees who are working on that process.*

Two respondents indicated specifying the ideal process to identify opportunities to improve the current process. This is often done in combination with VSM to reach the ideal situation through a stepwise approach.

Programme coordinator (2A): *And then you look for a certain ideal process. How should this process ideally be going? And then you discuss with each other: this is the current process, this is the ideal process, and how do we reach this.*

Two respondents indicated that the fishbone diagram, which is also known as the Ishikawa diagram, was used in their hospital. This tool is used to identify the root cause of a problem once it has been identified.

Program manager lean/manager quality (5A): *Hospital-wide, nobody says what is a value stream map. [...] the works council, nursing advisory board, managers, physicians, if they discuss something and want to identify causes, I frequently see a fishbone being used.*

4.2.2 Methods to organise more effective and/or efficient processes

The most frequently mentioned lean method used in the hospital to organise more effective and efficient processes was 5S. Additionally, the methods Kanban and specification of ‘standard procedures’ were mentioned three and two times, respectively. One-piece continuous flow, work redesign and pull were only mentioned once; thus, these last three methods are only shown in Appendix 6.

Four respondents mentioned 5S as a method to organise processes to improve efficiency. They used 5S to structure the workplace to reduce waste in the processes.

Programme coordinator (2A) stated the following: *5S is one of those methods we use to organise the workplace so that people lose less time searching in their jobs, because we cannot use the time we spend searching or replenishing materials on our customer or our patient.*

One of these respondents indicated they conducted a hospital-wide action based on 5S to organise the workplace and thus reduce the search time of employees.

Program manager lean/manager quality (5A): *We saw that many departments could not find things such as protocols or items within 60 seconds. So we did a hospital-wide, what we called sweeping action, based on 5S.*

Kanban was mentioned by three respondents as a method to improve inventory management in the hospital. They mentioned the use of Kanban in certain departments but that it was also used throughout the hospital.

Lean consultant (8A): *First, Kanban was implemented locally to reduce inventory. [...] everything reduced to week and day inventories. [...] Afterwards, Kanban was also implemented hospital wide. And this also reduced the inventory a lot.*

Two respondents indicated that standard procedures were specified in their hospitals with a focus on waste elimination. One of these respondents also mentioned that, in this way, processes were standardised, which allowed employees to more easily help out in other departments.

Lean manager (3A): *Especially in our bigger projects, we make a plan for securing maintenance, and in these plans, work instructions are mentioned and then, in particular, how many times you go back to these work instructions. [...] for instance, in a team meeting to inform everyone again about the protocols. This way you also realise standardisation for new employees.*

4.2.3 Methods to improve error detection, relay information to problem solvers and prevent errors from causing harm

Visual management was the most frequently mentioned lean method used in the hospital to improve error detection. The enhancement of adherence to standard procedures to improve error detection was mentioned just once; thus, this method is only shown in Appendix 6.

Six respondents mentioned the use of visual management in their hospitals. However, the respondents indicated different ways in which it was applied. Some respondents, for instance, used visual management to provide employees with information about how certain tasks should be performed.

Lean manager (3A) stated the following: *We are now working on a project creating visual lines and standard symbols throughout the whole hospital. This way, employees can go more easily from one*

department to another and take over tasks. We are very busy with this, especially in such a COVID time, in a COVID department.

Other respondents indicated that they used visual management to monitor certain processes. This way, important aspects of the process could be continuously monitored to quickly detect deviations.

Lean consultant (8A): *Also by displaying the important parts of the process visually on a board to improve every day. [...] use the colours red and green in particular. [...] visual management to monitor your processes.*

4.2.4 Methods to manage change and solve problems with a scientific approach

A team approach to problem solving events was the most frequently mentioned lean method used in the hospital to manage change and solve problems systematically. This was followed by A3 reporting systems and a management system for rapid problem investigation.

A team approach to problem solving was the second-most-mentioned method in the interviews overall. Nine out of 11 respondents mentioned the use of this method to manage change and to solve problems. They indicated that, during short and structured sessions, process agreements and challenges are discussed.

Manager quality advisors (1B) stated the following: *Lean offers beautiful things to intervene in the culture [...] such as day starts, in which you discuss daily with each other what the day is going to look like, what do we expect from each other, which challenges do we want to tackle today, who is going to do that and when. Those are actually all interventions aimed at changing behaviour and realising improvement.*

Four respondents indicated the use of A3 reporting systems in their hospitals to manage change and solve problems in a structured way.

Programme coordinator (2A): *When certain deviations are identified, then we use the A3 method, among others. [...] for instance, I encounter daily out-of-stock issues in the patient room, then we investigate together how this is happening.*

A management system for rapid problem investigation was mentioned by three respondents. One respondent indicated that certain issues that are identified during day start sessions on the shop floor can be discussed within a couple of hours by the board of directors.

Program manager lean/manager quality (5A): *In nearly every department, there is a day start each morning. [...] sometimes they also do a huddle; these are more aimed at annual goals [...] if something comes out of this, then these items are escalated on Monday or Friday, and every day during corona times, to the nine o'clock session with all 55 heads from the whole organisation and their management [...] they can say something about it, very structured [...] never about the content, only about the process agreements [...] some items cannot be solved; these have to go to twelve o'clock session with the board*

of directors. [...] this way, an item from the shop floor is discussed by the board of directors within a couple of hours.

Figure 5 illustrates the frequency of the different lean tools and methods used in the case hospitals. In the eight cases, 16 lean tools were mentioned. Among the 16 tools, six were mentioned by only one respondent. Value stream mapping was the most frequently mentioned tool (10 respondents), followed by team approach to problem solving (9 respondents) and visual management (6 respondents).

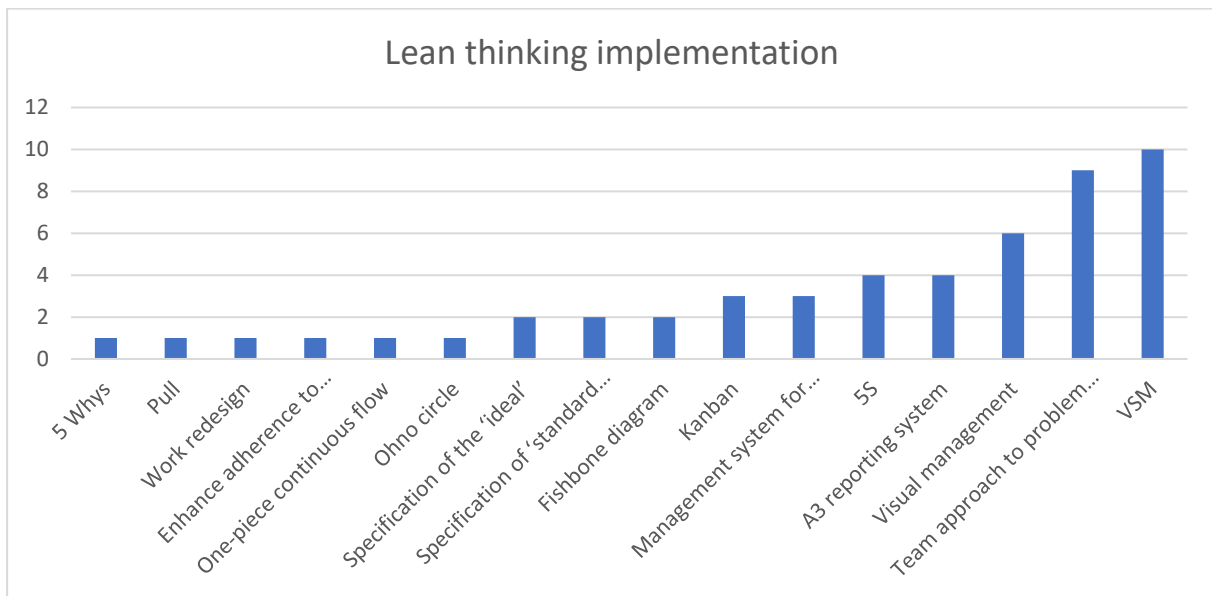


Figure 5 Frequency of different lean tools and methods mentioned in interviews

4.3 Enabling factors of lean interventions

In this section, findings related to the factors enabling lean interventions are presented. The complete coding scheme regarding to these findings is given in Appendix 7.

4.3.1 Situation and organisation

Competence was the most frequently mentioned enabling factor that relates to the situation, organisation or setting in which the interventions are deployed. Additionally, the factors vision and external support were mentioned five and two times, respectively. Experience, IT systems and alignment were only mentioned once; thus, these last three enabling factors are only shown in Appendix 7.

Competence was mentioned as an important enabling factor for the success of lean interventions by five respondents. However, a distinction can be made between competence in lean tools and methods and competence in change management. For instance, some of these respondents mentioned the importance of understanding what waste in the process is, what certain lean methods can be used for and how they work.

Business manager (7A) stated the following: *You must not only give people time to do it, but you also have to make sure that they know how to do it and you have to guide them in that, for instance, with a lean coach – people that know how to do this in the best way.*

Other respondents indicated the importance of knowledge about change management, for instance, in situations where an employee is the only one with a lean certificate in their department and they try to make improvements.

Lean manager (3A): *Look beyond just lean and six sigma [...] without basic knowledge about change management, how do you get people involved and how to deal with resistance, projects get stuck very fast. [...] hospitals are, how should I say it, political organisations with quite complex power structures.*

Five respondents indicated the importance of vision for successful lean interventions. They mentioned that reasons for the intervention should be clear and well explained and that there should be a sense of urgency.

Lean consultant (8A): *An important one is that you have to create support within the organisation. That people see very clearly why they do it. And for this, it is important that the organisation clearly explains what the goals are and what the organisation stands for. And that can be on high-level mission, vision [...] and translate that to goals per department.*

External support was mentioned by two respondents as an enabling factor. One of these respondents indicated that, through external support, they gained insights into best practices.

Programme coordinator (2A): *We are in the beginning and still supported by an external consultancy firm [...] they provide us with insights into how other organisations approached it and what they learned from it. [...] but it is also very important to work on securing it within your organisation.*

4.3.2 Characteristics of the intervention

The availability of resources was the most frequently mentioned enabling factor that relates to the characteristics of the interventions, followed by training, adaption and customer focus.

Six respondents indicated the importance of available resources in terms of time and budget for employees to work on making process improvements.

Lean consultant (8A) stated the following: *Make sure, especially in the beginning, that there can be investment in improving. [...] and that can be by making extra capacity available, or by sending people to training, making time for it.*

Training in lean principles, lean tools and methods, and in leadership and change management was indicated by six respondents as an important enabling factor. Some of these respondents mentioned the importance of training employees in lean principles.

Program manager lean/manager quality (5A): *75% of the employees are trained. All these employees have had basic training, or a yellow belt, or a green belt, and they know what the wastes are. So we get a lot of emails or requests in which they mention that they identified waste. They want to tell it proudly or ask for help.*

In addition, some respondents indicated the importance of considering the soft side, in terms of leadership and change management, during training.

Lean consultant (8A): *Training, give people the opportunity to read things through, make sure that knowledge is available internally so that you can help people, and can coach them. [...] training on methods, how to do 5S, how to do VSM. But also on how to coach people, how to handle the team, how to motivate people.*

Three respondents mentioned the importance of the adaption of certain terms when doing lean interventions. For instance, they suggested not calling it lean interventions or giving practical examples when using terms such as standardisation.

Lean coach (7B): *A healthcare professional is of course very autonomous and also educated that way [...] the word standardisation used on the training [...] that is not a term that makes professionals excited for lean. So, we do not use the word standardisation. [...] of course we use it because they also read it in literature, but then I always make an example from it.*

Two respondents mentioned that lean interventions should focus on the customer or patient. They indicated that employees are more willing and motivated to participate when they agree that certain interventions improve patient care.

Lean manager (3A): *The biggest motivation for people to work in healthcare is to deliver quality to patients. So, you notice that actually everything you do related to this motivates employees. They enjoy their work more because the care is improved.*

4.3.3 Local delivery process

Management support was the most frequently mentioned enabling factor that relates to the process through which the interventions are delivered, followed by staff involvement, teamwork and administrative support.

Eight out of 11 respondents indicated the importance of support by managers from different layers in the organisation when applying lean. They mentioned, for instance, that the board of directors should support it and that department heads or team leaders should facilitate it.

Programme coordinator (2A) stated the following: *We have a core team that is a delegation from different layers of the organisation. [...] these are the ambassadors, and they, especially in the beginning, made people enthusiastic to start working with it. This way, we could achieve the first successes.*

Likewise, one respondent mentioned the absence of management support as a reason for failure.

Quality advisor (6A): *But you see that, with certain management, it comes, is deployed broadly – we called it Lean Six Sigma – and then afterward it is less applied. Now, this is not talked about at all anymore in the hospital.*

Four respondents mentioned the importance of staff involvement when applying lean methods in the hospital. They indicated that employees need to be motivated to participate and that it is not something that should be forced on them top-down.

Manager quality advisors (1B): *When you work with professionals, people really need to be motivated to improve something. [...] I do not want to say that we do not do it otherwise, because you can always make good agreements about where to start with the improvements. But preferably you start with the people that want it.*

The importance of teamwork when applying lean methods was mentioned by two respondents. They indicated, for instance, that employees become enthusiastic when they work in a multidisciplinary manner on improving their processes.

Quality advisor (1A): *So by doing a VSM with everybody involved [...] then you see a behaviour change. Participants are inclined to map the process again with a VSM the next time.*

Two respondents mentioned administrative support in terms of project management or help on the work floor as an enabling factor.

Programme coordinator (2A): *We always provide, besides training in classrooms, support during the work. [...] top-down help in the first steps, but then also support to maintain in their department. This way, they experience a lot of support which is also beneficial for their learning process.*

4.3.4 Sustaining long-term improvement

A supportive culture was the most frequently mentioned enabling factor that relates to sustaining the improvements in the organisation over the long term, followed by communication, measurements, a systemwide scope, a holistic approach and continuous improvement.

Six respondents indicated the importance of a supportive culture in terms of the views, norms and beliefs within the hospital related to quality improvement. They indicated, for instance, that it is important to celebrate successes, but also mentioned that it is important to create an organisational culture in which people feel safe enough to make mistakes.

Program manager lean/manager quality (5A) stated the following: *Employees particularly say the fact that I can do it myself, discover it myself, can make mistakes, that is what makes it so enjoyable.*

This respondent also stated that the employees were no longer 'scared' of the lean terms and viewed it as the way things were done in the hospital.

Program manager lean/manager quality (5A): *By now, people do not get scared of those words anymore, and they do not think: What should I do with it? It actually became quite ordinary.*

Three respondents mentioned the importance of communication when applying lean. They indicated, for instance, that by sharing stories and giving feedback, people can learn from each other.

Lean coach (7B): *Also sharing the small things with each other in the department – learning with and from each other. Lean offers a platform for that, through a day start for instance.*

Measurements to monitor the processes were suggested by two respondents as an enabling factor. They mentioned that this stimulates continuous improvement and makes it possible to celebrate successes.

Lean consultant (8A): *Also, by display the important parts of the process visually on a board to improve every day. [...] use the colours red and green in particular. [...] visual management to monitor your processes.*

Two respondents indicated the importance of a systemwide scope when applying lean in the hospital. They mentioned that it must be carried out broadly throughout all layers of the organisation. One of these respondents, for instance, mentioned that they already convey it when hiring employees and to new board members.

Program manager lean/manager quality (5A): *In the selection procedure, you must know which people to hire. So, with the complete recruitment and selection of employees hospital-wide, but especially with key figures such as the board of directors, you have to secure maintenance.*

The importance of a holistic approach when applying lean was indicated by two respondents. They mentioned, for instance, that it is important that people start speaking the same language within the organisation.

Lean consultant (8A): *So you go in a stepwise approach through the whole organisation, where you learn every group-specific thing about how they should change to reach the whole lean philosophy.*

Continuous improvement in terms of perseverance and securing attention for this way of improving processes throughout the hospital was indicated as important by two respondents.

Programme coordinator (2A): *When there comes a new board, convince them that this is important in our organisation, where we need to pay attention to [...] or when there is a new manager that it is taken into consideration, or that physicians consider it when discussing issues.*

Figure 6 depicts the frequency of the different enabling factors of lean interventions mentioned by the respondents. In the eight cases, 20 enabling factors were mentioned. Among the 20 factors, three were only mentioned by one respondent. Management support was most the most frequently mentioned (8

respondents), followed by resources (6 respondents), supportive culture (6 respondents) and training (6 respondents).

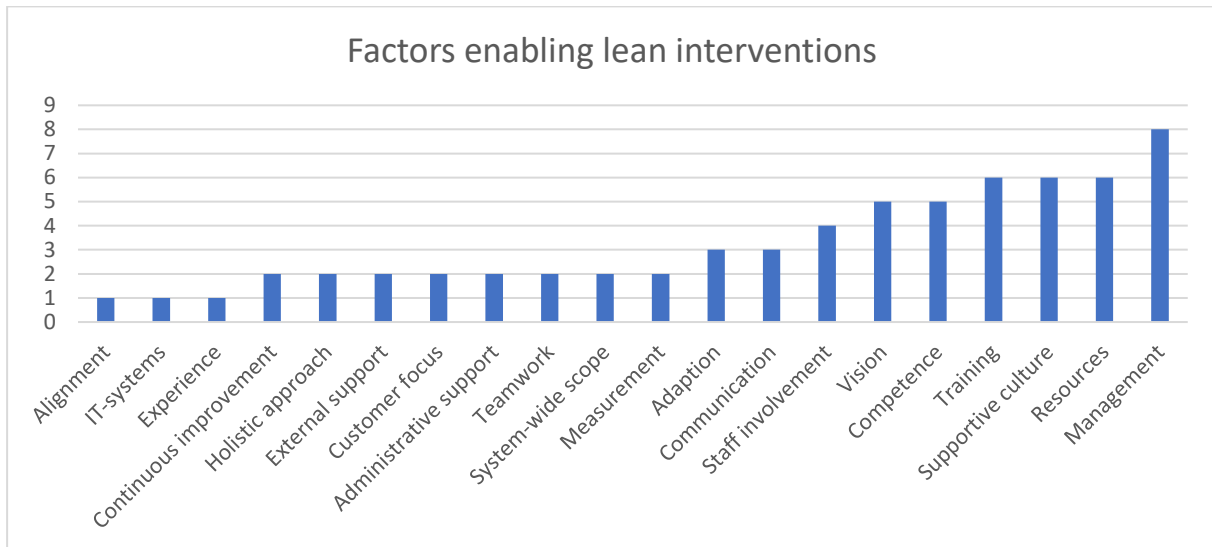


Figure 6 Frequency of factors enabling lean interventions mentioned in interviews

4.3 Lean thinking outcomes

In this section, findings related to the outcomes of lean thinking in the case hospitals are presented. The complete coding scheme regarding these findings is given in Appendix 8.

4.3.1 Hospital performance

Time savings was the most frequently mentioned effect of lean interventions on the performance of the hospital. Additionally, throughput time reduction and quality improvement were mentioned four and three times, respectively. Planning improvement, reduction of errors, and cost savings were mentioned two times. Patient satisfaction and improved patient safety were only mentioned once; thus, these last two outcomes are only shown in Appendix 8.

Overall, time savings was the second-most-mentioned outcome of the lean interventions in the case hospitals. Five respondents mentioned that the time it took to complete certain processes was reduced through the application of lean tools or methods. They indicated, for instance, that as a result of applying lean methods, employees spend less time searching or walking to complete processes.

Lean consultant (8A) stated the following: *They did not have to walk back to the gathering place. [...] on walking and searching they saved around 580 hours per year that could be used for quality and extra cleaning.*

Throughput time reduction was mentioned by four respondents as an outcome of lean interventions. They indicated, for instance, that waiting times between patient appointments were reduced or that lab results were made available more quickly.

Lean manager (3A): *Or about throughput time [...] how long does it take from the first visit of the physician until the first diagnosis, and can we decrease that.*

Three respondents indicated more general quality improvement outcomes of lean interventions. For example, one respondent indicated that improvements were made in the preparedness of patients for their examinations in terms of their medication use. Another respondent mentioned improvements in the dialysis department regarding connecting patients to the machines at the planned time. One respondent noted that the use of lean methods resulted in quality improvements such as mapped care paths needed for certain accreditation labels.

Quality advisor (1A): *Sometimes it is also about quality; for instance, for an accreditation label, just that extra step to map the care path so that it is not just in the heads of the employees but also on paper.*

Two respondents mentioned that improvements to the planning were realised with the use of lean. They indicated that improvements were made in determining patient discharge dates and times.

Program manager lean/manager quality (5A): *Physicians came up with an idea to improve hospital discharge because physician visits took too long [...] can we do a five-minute stand-up meeting – no substantive information about the patient, but, according to a certain structure, look at which patients are there and who can be discharged? This way, patients know at nine o'clock in the morning that they can go home at three o'clock.*

Reduction of errors was mentioned as a result of lean interventions by two respondents. The use of lean methods resulted in fewer cancelled appointments since the material availability was improved and a daily planning was continuously monitored.

Programme coordinator (2A): *Another example is where a patient had to wait six weeks for his treatment. [...] and sometimes the appointment was even cancelled on the same day because we did not have the right materials ready. [...] we reduced this to two weeks and where everything is right the first time.*

Two respondents mentioned cost savings were realised by using lean methods. One respondent indicated that the total inventory value was significantly reduced after implementing Kanban throughout the hospital. Another respondent indicated that cost savings were realised by preventing damage to equipment through the use of visual management.

Lean manager (3A): *We had problems with damage to the scopes used in the endoscopy [...] the cameras are very fragile, and we had around 10,000 euro's damage annually [...] made a picture of how the scope had to be placed in its container [...] the picture is now standard in the container and you put the scope on top of it.*

4.3.2 Development of employees and the work environment

Regarding the question of what the effects of the lean interventions on the employees of the hospital and the work environment are, job satisfaction was most frequently mentioned, followed by job control, learning ability, proactive attitude towards problem solving, improved team cohesion, communication and a balanced workload.

Job satisfaction was, overall, the most commonly mentioned outcome of lean in the interviews. Seven out of 11 respondents mentioned that employees experienced more satisfaction in their work by using lean. Some respondents indicated that employees were often highly enthusiastic about participating in applying lean tools, such as VSM, to their processes.

Program manager lean/manager quality (5A) stated the following: *Our employees' satisfaction increased [...] hospital-wide, lean is among the top three things they are most proud of.*

Four respondents mentioned that employees experienced more control over their work as a result of lean. One of these respondents indicated that employees gained more insight into how processes were going outside of their department.

Lean coach (7B): *And apparently also more control over their work by having much more understanding of how such a value stream works. Then, they can much better imagine how it goes outside of their department.*

Improved learning ability as a result of lean was mentioned by four respondents. For example, by mapping the process and discussing it together, employees can share their experiences and learn from each other.

Quality advisor (1A): *Learning ability is also much higher than when a separate system that is aimed at individuals is used, especially with visual management and discussing it with each other.*

In addition, one respondent indicated an improvement in the learning culture by using lean in the hospital.

Programme coordinator (2A): *You also see that it improves the learning culture and that this happens during the work and that it also contributes to keeping people in the organisation.*

A more proactive attitude towards problem solving was mentioned by four respondents as an outcome of applying lean. Some of these respondents mentioned that employees were inclined to solve problems again with lean methods when they participated earlier.

Program manager lean/manager quality (5A): *If you talk about culture and working according to the same improvement language. [...] if I say fishbone to physicians, then, in general, it does not scare them. [...] in our hospital, 155 physicians voluntarily joined our training.*

Three respondents mentioned increased team cohesion as a result of lean. They indicated, for instance, that when doing a VSM together or a day start session, the team building or team spirit becomes stronger. Business manager (7A): *During a day start, you can discuss in ten minutes what has to be done today, [...] make sure that you can do your job better and that the team building becomes stronger. [...] if you discuss it beforehand and divide the work, then a lot more cohesion and willingness to work is developed.*

Three respondents mentioned improved communication as a result of applying lean in the hospital. However, a distinction can be made between internal and external communication. Some respondents indicated that communication between employees or with management was improved through the use of lean methods, for instance, when discussing process agreements during day start sessions with each other or giving feedback.

Lean coach (7B): *But the nicest result of such a value stream session is that the grumblings among people stop. [...] now I get what all the fuss over this process and the checkmarks is about, okay, so how can we improve the patient care? And let's look at the process from another perspective.*

On the other hand, one respondent mentioned that communication with the patient had improved, which resulted in more attention given to the voice of the patient.

Programme coordinator (2A): *More attention to the voice of the patient; for instance, they can talk to us about what they find important when they are hospitalised.*

Two respondents mentioned that the workload in certain departments was better balanced when using lean methods. They indicated, for instance, that administrative burdens were reduced and better flow was created in the processes.

Lean consultant (8A): *Fewer peaks and troughs when working in the department. So that your work has a better flow. That, of course, gives the employees the result of a better-balanced workload throughout the day.*

Figure 7 illustrates the frequency of the different outcomes of the lean interventions mentioned by the respondents. In the eight cases, 15 outcomes were mentioned. Among the 15 outcomes, two were only mentioned by one respondent. Job satisfaction was most the most frequently mentioned (7 respondents), followed by time savings (5 respondents).

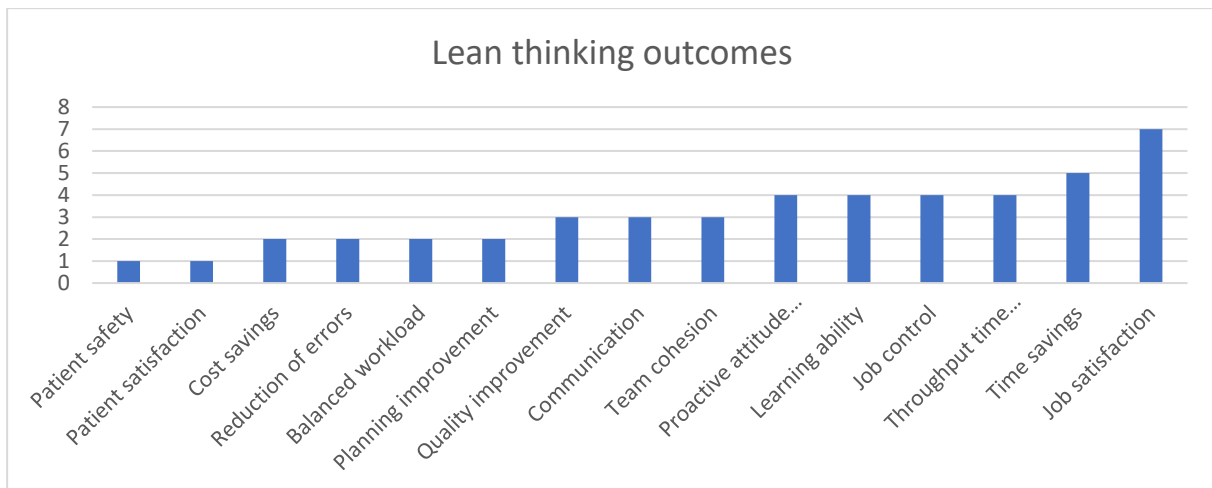


Figure 7 Frequency of different outcomes mentioned in interviews

4.5 Revised conceptual model

Based on the aforementioned findings, the conceptual model constructed in Chapter 2 can be revised. The relationship between the main variables remained the same. However, some subvariables identified in the literature review were not mentioned by any of the respondents during the interviews. Similarly, some subvariables that were not identified in the literature review were mentioned during the interviews. The revised conceptual model is depicted in Figure 8.

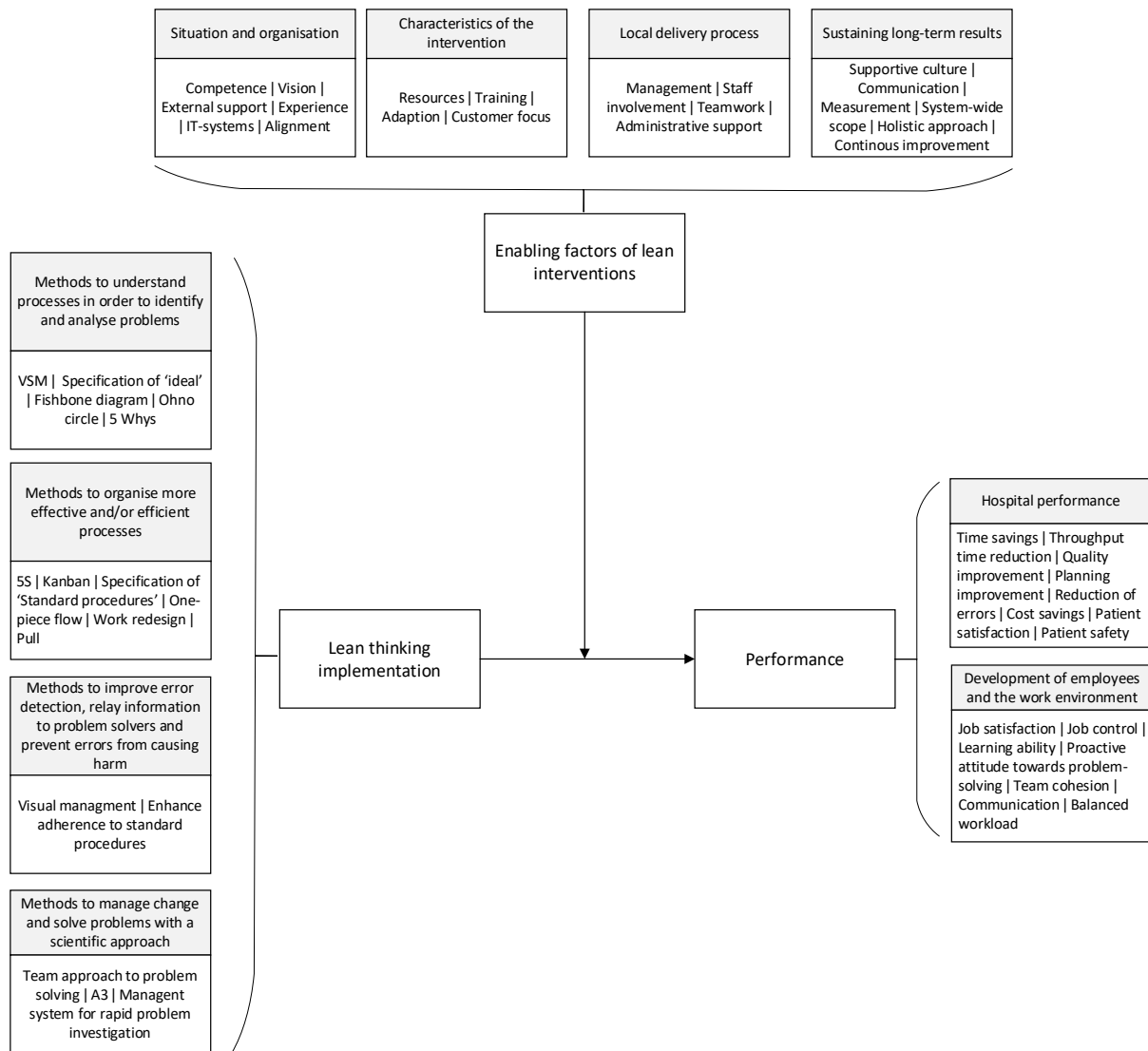


Figure 8 Revised conceptual model

Chapter 5: Discussion

In this chapter, the findings of this research are discussed, followed by the limitations of this study and recommendations for future research on lean thinking in hospitals.

5.1 Lean thinking implementation in hospitals

The findings of this study demonstrate that the case hospitals applied lean in various departments and functions throughout the hospital. However, as indicated by Akmal et al. (2020), it can be difficult to distinguish organisations that implement lean with a focus only on tools from organisations that use a systemwide approach.

The results show that, on average, the respondents mentioned the use of seven different lean methods throughout their hospitals. The lean methods VSM, a team approach to problem solving, and visual management were most frequently mentioned by the respondents. Many authors have indicated that these are among the most used lean methods in hospitals (Akmal et al., 2020; Poksinska, 2010; Mazzocato et al., 2010).

The results also suggest that lean tools and methods are applied with various scopes. In some cases, the tools are applied only within the boundaries of a department. However, in the case of VSM, for instance, it is also used across departments or even includes processes outside the boundaries of the hospital. In addition, the lean methods are used in different layers of hospitals, for instance, when using a similar approach for discussing process agreements during a day start session in different management levels. Furthermore, in some cases, visual management is used within departments to monitor processes or throughout the hospital to, for instance, help employees perform certain tasks in other departments more easily.

The results further demonstrate that the case hospitals intervened in the culture and tried to focus on continuous improvement. Respondents referred, in particular, to the two most mentioned lean methods, VSM and day start sessions, as methods to create process understanding among the employees aimed at changing behaviour. This is also indicated as an element of a systemwide approach by Mazzocato et al. (2010), who emphasise that lean should be a long-term philosophy and that quality improvement should become everyone's responsibility in organisations.

Many authors agree that lean is often focused only on a single department or function, instead of on a whole system, or that it is focused on tools instead of on the philosophy or the way of thinking (Akmal et al., 2020; Mazzocato et al., 2010; D'Andreamatteoa et al., 2015). However, this narrow implementation is not clearly reflected in the findings of this study. This may indicate that the lean implementation in Dutch hospitals is relatively more mature than in other countries.

5.2 Enabling factors of lean interventions in hospitals

Overall, the findings demonstrate once more that, for lean to be a success, it is not just a matter of implementing tools and methods. To ensure successful lean implementation, some important enabling factors should be taken into consideration.

The findings regarding enabling factors that relate to the situation, organisation or setting in which the interventions are deployed reveal that competence and vision were most frequently mentioned. The results suggest that it is important that employees understand what waste in the process is and how certain lean methods can be used, but also that people who lead certain lean interventions or lean projects have knowledge about change management to motivate people and get them involved. Similar results were found by Andersen et al. (2014), who argue that employees should have the competence in tools and methods to be able to take initiative and make improvements; however, they do not emphasise the importance of competence in change management skills. Moreover, the reasons for conducting lean interventions should be well explained, and there should be a clear sense of urgency. This is also mentioned by D'Andreamatteoa et al. (2015), who assert that lean interventions should have a clear definition of quality targets, such as patient safety or economic performance.

The findings regarding enabling factors that relate to the characteristics of the interventions reveal that resources and training were the most frequently mentioned. The results suggest that time and budget should be made available so that employees have the opportunity to work on making process improvements. This is also mentioned by Holden (2011), who argues that these resources are needed to do a thorough job. Furthermore, the results indicate that training should be provided in lean principles, lean tools and methods, and leadership and change management. Poksinska (2010) further states that, through these trainings, employees can create a new way of thinking about their work where they feel that they can take initiative and utilise their skills and creativity to make thinking happen. However, again, there is no emphasis on the soft side of lean in terms of leadership and change management. It could be that the soft side of lean is considered to be more related to management support. Nevertheless, it may be worth including this in employee training as well, since some respondents mentioned that employees sometimes find it difficult to improve something when they are the only ones with knowledge about lean in their department.

The findings regarding enabling factors that relate to the process through which the interventions are delivered reveal that management support was most frequently mentioned. The results indicate that, of all enabling factors, support by managers from different layers in the organisation when applying lean is vital. For instance, the board of directors should support the lean implementation, and department heads or team leaders should facilitate it. This has also been shown by many other authors; for instance, Akmal et al. (2020) assert that support from managers at all levels is an important factor in successful

lean implementation. In addition, the findings of this research indicate the importance of continuity in management support; they suggest that the absence of management support is, at first, a reason for reduced application of lean and eventually leads to complete disappearance.

The findings regarding enabling factors that relate to sustaining the improvements in the organisation over the long term reveal that supportive culture was most frequently mentioned. The results suggest that the views, norms and beliefs within the hospital related to quality improvement should be stimulated, for instance, by celebrating successes, but also by creating an organisational culture in which people feel safe enough to make mistakes. This can stimulate the development of a culture in which employees are no longer 'scared' of the lean terms and view it as the way things are done in the hospital. A supportive culture has also been identified as a key enabler by other authors (Akmal et al., 2020; D'Andreamattea et al., 2015; Poksinska, 2010).

5.3 Outcomes of lean thinking in hospitals

Overall, the findings of this study indicate that lean had a positive impact on performance in the case hospitals. The outcomes of lean interventions can be divided into effects on hospital performance and effects on employees of the hospital and the work environment (Poksinska, 2010). This distinction is further evident in the results of this study.

The findings demonstrate that outcomes of lean interventions on hospital performance in relation to time savings and throughput time reduction were the most frequently mentioned. The results show, for instance, that employees spend less time searching or walking to complete processes. This was also found by Mazzocato et al. (2010), who note that time savings is among the most common areas of improvement. Furthermore, the findings show that throughput time is reduced by, for instance, reduced waiting times between patient appointments or by faster lab results. Akmal et al. (2020) indicate that reduced waiting times or length of stay was the most common impact of lean in the articles they reviewed.

The findings further revealed that, of the outcomes of lean interventions on the development of employees and the work environment, job satisfaction and job control were most frequently mentioned. Overall, job satisfaction was the most commonly mentioned outcome of lean. Employees are often highly enthusiastic about participating in the application of certain lean tools, and they experience more satisfaction in their work by using lean. Other authors have also demonstrated the positive impact of lean on job satisfaction; however, in most studies, it is clearly not the most common result of lean (Akmal et al., 2020; Mazzocato et al., 2010; Poksinska, 2010). Moreover, the results suggest that employees can experience more control over their work, for instance, since they gain more insight into how processes are going outside of their department. This outcome of lean interventions is not specified in the articles mentioned in the theoretical framework.

5.4 Limitations of this study and recommendations for future research

A potential limitation of this study was the possibility of selection bias when collecting data from the case hospitals. Six out of seven case hospitals were part of the knowledge network Lean in Healthcare. Respondents from these case hospitals indicated positive results of lean interventions. The respondent from the case hospital that was not part of this network indicated why lean was no longer used. It is possible that, if more hospitals outside of this network were investigated, some negative effects of lean on performance could be identified.

Another potential limitation is the broad scope of this research. Narrowing the scope to one lean method or one enabling factor could provide a more detailed explanation of the relationship between a certain lean intervention and performance. The effects of the enabling factor on this relationship could then be investigated in greater detail.

Future studies should investigate particular aspects of the enabling factors, such as the importance of including soft side elements of lean interventions in training given to hospital employees and managers. Future studies should also look at hospitals outside of the Lean in Healthcare network to obtain unbiased results regarding the effects of lean interventions.

Chapter 6: Conclusion

This research aimed to understand how lean thinking can be successfully implemented in Dutch hospitals to improve performance. To investigate this, a qualitative research study was conducted based on eight cases with the aim to generate an in-depth understanding of lean thinking in Dutch hospitals.

This study revealed that, among the 16 lean tools and methods indicated within the interviews, value stream mapping (VSM) was the most frequently mentioned (10 respondents), followed by team approach to problem solving (9 respondents) and visual management (6 respondents). Other authors have indicated that these are some of the most used lean methods in hospitals (Akmal et al., 2020; Poksinska, 2010; Mazzocato et al., 2010).

While many authors agree that lean is often implemented with a narrow view, focusing only on a single department or function or certain tools, instead of a holistic view, this study does not clearly reflect this narrow implementation. The results of this study indicate that lean tools and methods are applied with varying scopes. In some cases, the tools are applied only within the boundaries of a department. In other cases, they are applied across departments, through different layers of the hospitals, or even including processes outside the boundaries of the hospital. In addition, the results indicate that the case hospitals intervene in the culture and try to focus on continuous improvement, for instance, through VSM and day start sessions, to create process understanding among the employees aimed at changing behaviour.

This study revealed that, among the 20 enabling factors of lean interventions indicated during the interviews, management support was the most frequently mentioned (8 respondents), followed by resources (6 respondents), supportive culture (6 respondents) and training (6 respondents). Many other authors have indicated these to be important enabling factors of lean interventions. For instance, Akmal et al. (2020) indicate that support from managers at all levels is an important factor in successful lean implementation. Furthermore, Holden (2011) argues that resources are needed to do a thorough job when implementing lean. In addition, Poksinska (2010) identifies a supportive culture as a key enabler and mentions the importance of employee training to create a new way of thinking about their work.

This study also found that, among the 15 outcomes of lean interventions indicated during the interviews, job satisfaction was most the most frequently mentioned (7 respondents), followed by time savings (5 respondents). Other authors have also demonstrated the positive impact of lean on job satisfaction; however, in most studies, this is clearly not the most commonly indicated result of lean (Akmal et al., 2020; Mazzocato et al., 2010; Poksinska, 2010). Furthermore, time savings is often among the most common areas of improvement with lean, as indicated by Mazzocato et al. (2010).

To better realise the potential benefits of lean, such as increased job satisfaction and time savings, hospitals should focus on some important enabling factors when applying lean tools and methods. Most important is that the lean interventions are supported by managers at all levels in the organisation and that time and budget resources are made available so that employees have the opportunity to work on making process improvements. Furthermore, a supportive culture should be created, where the views, norms and beliefs within the hospital in relation to quality improvement are stimulated. Finally, training in lean principles, lean tools and methods, and leadership and change management should be provided to hospital employees and managers.

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Appendix 1 - Consent form

This appendix is not included for confidentiality reasons.

Appendix 2 - Interview guide - Dutch

Interview guide

Inleiding

Mijn naam is Sander Limpers, voor de studie Supply Chain Management aan de Tilburg Universiteit ben ik momenteel bezig met mijn master thesis. Ik ga onderzoeken hoe lean denken wordt toegepast in Nederlandse ziekenhuizen en wat hiervan die uitkomsten zijn. Daarnaast wil ik erachter komen welke factoren bijdragen aan succesvolle lean interventies. Hiermee hoop ik inzicht te kunnen verschaffen in hoe lean effectiever toegepast kan worden in ziekenhuizen.

Ik wil graag melden dat het interview volledig anoniem zal blijven. Met uw toestemming zou ik graag een audio-opname van het interview maken. Deze opname zou ik dan kunnen gebruiken bij het uitwerken van de data. Het interview zal ongeveer 30 minuten duren. Dan zou ik nu graag willen beginnen met het stellen van de eerste vraag.

Algemene vragen

1. Wat is uw functie binnen (naam van ziekenhuis)?
 - Kunt u kort toelichten wat uw rol en taken binnen (naam van ziekenhuis) zijn?
2. Hoelang bent u al werkzaam in uw huidige functie?
3. Kunt u beschrijven wat het concept lean voor u betekent?

Lean thinking implementatie

4. Kunt u enige lean methodes noemen die jullie gebruiken om processen inzichtelijk te maken voor het identificeren van problemen?
 - Hoe passen jullie deze tools toe?
5. Kunt u enige lean methodes noemen die jullie gebruiken om de efficiëntie en effectiviteit van processen te verhogen?
 - Hoe passen jullie deze tools toe?
6. Kunt u enige lean methodes noemen die jullie gebruiken om fout herkenning door medewerkers te verbeteren?
 - Hoe passen jullie deze tools toe?
7. Kunt u enige lean methodes noemen die jullie gebruiken op een systematische manier verandering te beheren en problemen op te lossen?
 - Hoe passen jullie deze tools toe?

Lean thinking uitkomsten

8. Kunt u enige resultaten beschrijven van de zojuist genoemde lean interventies op de prestatie van (naam van ziekenhuis)?
9. Kunt u enige resultaten noemen die betrekking hebben op de medewerkers en de werkomgeving?

Bijdragende factoren voor lean interventies

10. Wat zijn volgens u de belangrijkste factoren die bijdragen aan het succes van de lean interventies?

- Waarom denkt u dat vooral deze factoren belangrijk zijn?

11. Kunt u nog andere factoren benoemen waarvan u ook denkt dat deze van belang zijn?

Afsluiting

Hartelijk dank dat u vandaag tijd heeft gemaakt om met mij te praten.

12. Heeft u zelf nog iets dat u wilt toevoegen aan dit interview?

13. Kunt u nog andere personen aanbevelen binnen de (naam van ziekenhuis) die ik zou kunnen benaderen voor een interview over dit onderwerp?

Appendix 3 - Interview guide - English

Introduction

Only in Dutch version of interview guide

General questions

1. What is your function at (hospital name)?
 - Could you briefly describe your role(s) and your tasks in the organisation?
2. How long are you employed at (hospital name)?
3. Could you explain what the concept of lean means to you?

Lean thinking implementation

4. Could you describe any lean methods used to understand the process in order to identify and analyse problems?
 - How were they applied?
5. Could you describe any lean methods used to organise more effective and/or efficient processes?
 - How were they applied?
6. Could you describe any lean methods used to improve error detection by employees?
 - How were they applied?
7. Could you describe any lean methods used to manage change and solve problems in a systematic way?
 - How were they applied?

Lean thinking outcomes

8. Can you describe any results of the lean interventions related to the performance of (hospital name)?
 - Why do you think these factors are important?
9. Can you describe any other results related to the development of employees and the work environment?

Enabling factors of lean interventions

10. What do you think are the most important factors that contributed to the success of the lean interventions?
11. Can you give any more examples of factors enabling successful lean interventions?

Closing

Thank you very much for taking the time today to talk with me.

12. Do you have anything else that you would like to add to this interview?
13. Can you recommend any other persons from (hospital name) that I could contact for an interview about this topic?

Appendix 4 – Interview transcripts

This appendix is not included for confidentially reasons.

Appendix 5 - Overview of codes

Key-concepts	Dimensions	Elements	Codes
Lean thinking implementation (LI)	Methods to understand processes in order to identify and analyse problems (MU)	VSM (VSM)	(LI-MU-VSM)
		Process mapping (PM)	(LI-MU-PM)
		5 Whys (FW)	(LI-MU-FW)
		5S (FS)	(LI-MU-FS)
		Specification of the 'ideal' (SI)	(LI-MU-SI)
	Methods to organise more effective and/or efficient processes (MO)	Process orientation (PO)	(LI-MO-PO)
		Specification of 'standard procedures' with focus on waste elimination (SP)	(LI-MO-SP)
		Physical work setting redesign (PWR)	(LI-MO-PWR)
		One-piece continuous flow (OF)	(LI-MO-OF)
		Kanban (KA)	(LI-MO-KA)
		5S (FS)	(LI-MO-FS)
		Process streaming (PS)	(LI-MO-PS)
		Pull (PU)	(LI-MO-PU)
		Rapid changeover time (RT)	(LI-MO-RT)
		Workload balancing (WB)	(LI-MO-WB)
		Two-piece continuous flow (TF)	(LI-MO-TF)
		Work redesign (WR)	(LI-MO-WR)
		Multidisciplinary task training (MT)	(LI-MO-MT)
	Methods to improve error detection, relay information to problem solvers, and prevent errors from causing harm (MI)	Visual management (VM)	(LI-MI-VM)
		Enhance adherence to standard procedures (AS)	(LI-MI-AS)
		5S (FS)	(LI-MI-FS)
		Patient safety alert system and 'Stop the line' (PS)	(LI-MI-PS)
	Methods to manage change and solve problems with a scientific approach (MM)	Team approach to problem solving and rapid process improvement events (TA)	(LI-MM-TA)
A3 reporting system (AT)		(LI-MM-AT)	
Management system for rapid problem investigation ('Go to gemba') (MR)		(LI-MM-MR)	
Patient safety alert system and 'Stop the line' (PS)		(LI-MM-PS)	
Lean thinking outcomes (LO)	Hospital performance (HP)	For example: patient throughput, time savings, productivity, patient safety, reduction of errors and mistakes	(LO-HP)
	Development of employees and the work environment (DEW)	For example: increased attention to waste, proactive attitude towards problem solving, process understanding, calmer work environment	(LO-DEW)
Enabling factors of lean interventions (EFL)	Context: Situation and organization (SO)	External support (ES)	(EFL-SO-ES)
		Vision (VI)	(EFL-SO-VI)
		IT-systems (IT)	(EFL-SO-IT)
		Alignment (AL)	(EFL-SO-AL)
		Competence (CO)	(EFL-SO-CO)
		Experience (EX)	(EFL-SO-EX)
		Belief (BE)	(EFL-SO-BE)
		Training (TR)	(EFL-CI-TR)
		Accurate data (ACD)	(EFL-CI-ACD)

	Content: Characteristics of the intervention (CI)	Resources (RE)	(EFL-CI-RE)
		Customer focus (CF)	(EFL-CI-CF)
		Adaption (AD)	(EFL-CI-AD)
	Application: Local delivery process (LDP)	Management (MA)	(EFL-LDP-MA)
		Teamwork (TE)	(EFL-LDP-TE)
		Physicians (PH)	(EFL-LDP-PH)
		Staff involvement (SI)	(EFL-LDP-SI)
		Administrative support (AS)	(EFL-LDP-AS)
	Outcomes: Securing achieved results (RM)	Supportive culture (SC)	(EFL-RM-SC)
		System-wide scope (SWS)	(EFL-RM-SWS)
		Continuous improvement (CI)	(EFL-RM-CI)
		Communication (CO)	(EFL-RM-CO)
		Holistic approach (HA)	(EFL-RM-HA)
Measurement (ME)		(EFL-RM-ME)	

Appendix 6 - Coding scheme - Lean thinking implementation

Lean thinking Implementation	Element	Respondents quote
Hospital 1 – Respondent 5 – quality advisor		
Methods to understand processes	VSM	We use the value stream map to really map the process from start to finish, and not just the process steps but also where the bottlenecks and obstacles are. What can we do to remove these and create as much value for the patient as possible.
Methods to organise processes	Kanban	The Kanban technique is used throughout the hospital.
Methods to improve error detection	5S	5S is used on departments but not a lot, and then they often need help with applying it. But I do not see much continuity in it.
	Visual management	Learning ability is also much higher than when a separate system that is aimed at individuals is used, especially with visual management and discussing it with each other.
Methods to manage change	Team approach	Some departments work with an improvement board. What is the problem? What do you encounter? How can we improve it? Who is responsible?
	A3	Yes, that is what we call an improvement board.
	Team approach	Not that many departments that use day starts very well. I think this has to do with how the board of directors conveys the message and that no hard label of lean is linked to it. [...] I see that it would help departments if we would do it.
	Management system for rapid problem investigation	At the intensive care, for instance, they use an improvement board for their incident notifications [...] by discussing this together daily they solve these incidents much faster.
Hospital 1 – Respondent 10 - Manager quality advisors		
Methods to understand processes	VSM	The big method that we use is the value stream map. [...] we do that almost always when there is an existing process that needs to be improved. [...] we use that rather standardised, and then we map the process with a big group of employees who are working on that process.
	VSM	Based on the goal we chose how to approach the value stream map [...] throughput time, processing time, issues we want to reduce [...] but sometimes it also a very pragmatic question in which people ask for instance this process is not working properly [...] than we just want to improve the current bottlenecks.
	5 Whys	And then with the five times why questions identify why a certain problem occurs and if that is clear then we can adjust the process in such a way that we can tackle this problem.
Methods to manage change	Team approach	Lean offers beautiful things to intervene in the culture [...] such as day starts, in which you discuss daily with each other what the day is going to look like, what do we expect from each other, which challenges do we want to tackle today, who is going to do that and when. Those are actually all interventions aimed at changing behaviour and realising improvement.
Hospital 2 – Respondent 6 - Programme coordinator		
	Fishbone diagram	Within the A3 there are multiple techniques to properly perform your plan, do, check, act [...] where does the problem actually exist. For this we use a root cause analysis among others, often fishbone analysis.

Methods to understand processes	VSM	For instance, at a polyclinic [...] when the waiting times are too long before you can be hospitalised. Then you can do a value stream analysis within the A3 to see: what steps do the patient go through; where is the waste; and where are possible improvements.
	VSM	But also already for something very small: how is the process working for a new email address? If that takes too long, or is annoying, or does not add value for the patient then you can use it as well.
	Specification of the 'ideal'	And then you look for a certain ideal process. How should this process ideally be going? And then you discuss with each other: this is the current process, this is the ideal process, and how do we reach this.
Methods to organise processes	5S	5S is one of those methods we use to organise the workplace so that people lose less time searching in their jobs, because we cannot use the time we spend searching or replenishing materials on our customer or our patient.
Methods to manage change	Team approach	We often start with a day start, we also call it day evaluation. [...] did you miss anything, was there a patient or customer not satisfied, did you encounter things that you want to improve.
	A3	When certain deviations are identified, then we use the A3 method, among others. [...] for instance, I encounter daily out-of-stock issues in the patient room, then we investigate together how this is happening.
	Team approach	We do many day starts and day evaluation in the organisation [...] it is like putting on glasses through which you look at your work and notice many things that actually do not add value for the employee, the organisation, as well as for the customer of the process.
Hospital 3 – Respondent 7 - Lean manager		
Methods to understand processes	VSM	We use the value stream map, but they are used to understand where the bottlenecks are.
Methods to organise processes	5S	Quite a lot of 5S is u the departments.
	Specification of 'standard procedures'	We are now working on a project creating visual lines and standard symbols throughout the whole hospital. This way, employees can go more easily from one department to another and take over tasks. We are very busy with this, especially in such a COVID time, in a COVID department.
	Specification of 'standard procedures'	Especially in our bigger projects, we make a plan for securing maintenance, and in these plans, work instructions are mentioned and then, in particular, how many times you go back to these work instructions. [...] for instance, in a team meeting to inform everyone again about the protocols. This way you also realise standardisation for new employees.
Methods to improve error detection	Visual management	We use visual management quite a lot, things such as lines.
	Visual management	We had problems with damage on the scopes used at the endoscopy [...] the cameras are very fragile and we had around 10.000 euro's damage annually [...] made a picture of how the scope had to be placed in its container [...] the picture is now standard in the container and you put to scope on top of it.
	Visual management	We are now working on a project creating visual lines and standard symbols throughout the whole hospital. This way, employees can go more easily from one department to another and take over tasks. We are very busy with this, especially in such a COVID time, in a COVID department.
	Visual management	To secure maintenance we also make measuring plans and make sure that improvements that we implemented from the team meetings are measured and that we keep managing these on daily basis. [...] we keep track of that and make it visual.
Methods to manage change	Team approach	The day starts in the departments, and there is an improvement board present so that the translation can immediately be made to: What can we do about it? What caused it?

Hospital 4 – Respondent 8 and Respondent 9 – lean coaches		
Methods to understand processes	VSM	We use the value stream analysis a lot in particular.
	VSM	We first mapped the current situation with team managers and employees from the work floor by using a value stream map.
	VSM	We mapped the process starting from the referral given by the general practitioner, to how does the patient enter the hospital area, even until the moment the patient leaves the area.
	VSM	One nursing department noticed that they could not determine the discharge in advance [...] Eventually we did a value stream analysis for this process and we noticed that there were various standard tasks [...] this appointment is now planned at the same time when the operation is planned. [...] so the patient can go home at eleven o'clock the next day.
Methods to improve error detection	Enhance adherence to standard procedures	We work with many protocols and checklists, and then you notice quite quick if something is going wrong.
	Visual management	In some projects we work with standardisation by adding visualisations.
	5S	The complete inventory management is organised with 5S and kanban systems, then of course you notice deviation very quickly.
	Visual management	In the emergency department patients gave use feedback that they sometimes did not know where they were waiting on. [...] we did a project in which every patient is seen within ten minutes by a nurse. [...] with a colour system we differentiate between patients with severe injury and less severe injury.
Methods to manage change	Management system for rapid problem investigation	Go to Gemba is used a lot.
	Management system for rapid problem investigation	Primarily where it happens that is called Go to Gemba, by project leaders, or by team managers, or by employees.
	Team approach	Day starts are done very much in the hospital. I think that almost every department has a day start board, an improvement board, and some teams do it once a week while others do it every day.
	A3	I notice that it also offers some structure. They mention, for instance, that it is nice to work with A3 to keep your project in control.
Hospital 5 – Respondent 11 - Program manager lean/manager quality		
Methods to understand processes	VSM	The general practitioner mentioned that the telephone accessibility of the hospital was not good sometimes. [...] we made a value stream analysis together with a general practitioner.
	Fishbone diagram	Hospital-wide, nobody says what is a value stream map. [...] the works council, nursing advisory board, managers, physicians, if they discuss something and want to identify causes, I frequently see a fishbone being used.
Methods to organise processes	5S	We saw that many departments could not find things such as protocols or items within 60 seconds. So we did a hospital-wide, what we called sweeping action, based on 5S.

Methods to improve error detection	Visual management	Throughout the whole hospital, these boards are installed, almost in every department. [...] we call the huddle boards [...] we see that these bring much structure.
Methods to manage change	Team approach	That core team had a stand-up meeting once a week. [...] what are we doing, what is happening in the organisation, what can we do to put it into practice.
	Management system for rapid problem investigation	In nearly every department, there is a day start each morning. [...] sometimes they also do a huddle; these are more aimed at annual goals [...] if something comes out of this, then these items are escalated on Monday or Friday, and every day during corona times, to the nine o'clock session with all 55 heads from the whole organisation and their management [...] they can say something about it, very structured [...] never about the content, only about the process agreements [...] some items cannot be solved; these have to go to twelve o'clock session with the board of directors. [...] this way, an item from the shop floor is discussed by the board of directors within a couple of hours.
	Team approach	Physicians came up with an idea to improve hospital discharge because physician visits took too long [...] can we do a five-minute stand-up meeting – no substantive information about the patient, but, according to a certain structure, look at which patients are there and who can be discharged? This way, patients know at nine o'clock in the morning that they can go home at three o'clock.
	Management system for rapid problem investigation	I come one time a week, the past half year three times a week, with the board of directors on the shop floor to the employees [...] to ask how applying the lean philosophy is going.
Hospital 7 – Respondent 2 – Business manager		
Methods to understand processes	VSM	primarily, the value stream is used a lot.
	VSM	Then you take a look at all the process steps [...] you try to get a clear picture of what is happening in the process and then analyse it to figure out what the reason is that things are not going as we had hoped.
Methods to organise processes	Specification of 'standard procedures'	A registration tool is not used properly, so the registrations are incorrect. This tool was once developed because nurses encountered certain problems, but then it turns out that they do not need this checklist to solve the real problem.
Methods to manage change	Team approach	It can happen that in a team two people are very busy and two people have nothing to do [...] during a day start you can discuss in ten minutes what has to be done today, [...] and who needs help.
	Team approach	During a day start, you can discuss in ten minutes what has to be done today, [...] make sure that you can do your job better and that the team building becomes stronger. [...] if you discuss it beforehand and divide the work, then a lot more cohesion and willingness to work is developed.
	Team approach	And the power of lean is that such a day start does not become just a nice chat [...] but stick to a fixed schedule, with a board [...] than it is quickly done.
Hospital 7 – Respondent 3 – Lean coach		
Methods to understand processes	VSM	The value stream analysis, that is the most used tool which is easy to use and broadly applicable.
	Specification of the 'ideal'	From the value stream we look at what is the ideal situation and how can we reach this in a stepwise approach.

	VSM	When we encounter in the value stream that there are many loops back, that things do not go right the first time, then we decide what to do with this.
	VSM	We made a value stream [...] than you notice that clinical instruments do not pick out the patients that you would wish. Because despite the screening, the patients still develop this disease. Then you get into a very medical discussion.
Methods to organise processes	Pull	From push to pull. We already did that on small scale. But now we are going to do this on a bigger scale during a black belt project.
	Pull	For hiring new employees [...] to make sure they can do their job properly from day one. We want to convert that from push to pull and with this bring to the surface problems that do not go well the first time.
	Kanban	That there is a note at the moment you reach the fifth diaper or infusion equipment. And then you can order it again. For this we use it sometimes.
Methods to improve error detection	Visual management	We use, for instance at the clinical pharmacy, a daily planning board on which we mention all tasks, their priority, and the order in which they need to be carried out. This means that things cannot be forgotten anymore.
	Visual management	A pharmacy assistant was scheduled to take care of the medication administration for new patients. [...] five half days a week, an assistant was doing this, and can you imagine this was for 300 patients a year. [...] they were constantly working six weeks ahead [...] what value do you deliver your patients and that turned out to be only 24 hours before. [...] we decided to make it visual through a daily planning list, on which you can check if there will be new patients tomorrow and then perform the actions.
	Visual management	There are also some visual elements present in the systems. [...] then it shows a red cross for the medicine recipe, and then we know the physician approved it [...] some of these elements were already there but in lean processes we give extra attention to this.
Methods to manage change	Team approach	We use day starts, on a big scale. I believe that we now have 24 of them in the organisation. And during these signals of problems come up.
	A3	We use the A3 method to solve problems in a structured way.
	Team approach	To notice deviation [...] we have implemented a day start at which we stick to a fixed sequence of tasks. Here occasionally something was forgotten because it was a really small task. And now we discuss each morning who is going to do this task. This way we prevent a mistake by not doing something.
	A3	We use this mainly when people are doing projects. It is less used if small improvements are made within departments.
Consultancy firm – Respondent 4 – Lean consultant		
Methods to understand processes	VSM	Also, however not a lot, for some processes a VSM was made to make the process comprehensible. And from this look at points to improve, where should we do kaizens to improve the process.
	Ohno Circle	Another method is to let the people see the process, which is called Ohno Circle, to let people see their own process and let them see where value is created and where there is waste in the process. Then these wastes are nice kaizens to improve.
	VSM	We made a VSM and it turned out there were 36 or 37 steps to set to invoice to payable [...] we looked at which process steps were really needed in the process [...] and through innovation and kaizens we brought this process back to seven steps. And with the throughput time from 38 days to six days.
Methods to organise processes	One-piece flow	To switch from working in a batch approach on the lab where you collect material at one moment [...] to a one-piece flow where materials are used every minute.
	Kanban	First, Kanban was implemented locally to reduce inventory. [...] everything reduced to week and day inventories. [...] Afterwards, Kanban was also implemented hospital wide. And this also reduced the inventory a lot.
	Work redesign	What we also did was to organise the process differently so that people had to walk less. [...] we reduce this from 500 to 25 pieces which made it possible for the department to order it themselves and the nurses did not have to walk down each day or a few times a week.

	Kanban	Afterward, kanban is also implemented hospital-wide. And this also reduced the inventory a lot. [...] a huge amount of inventory value was reduced in the hospital.
	Kanban	By implementing kanban in the lab, and not working with order lists anymore, resulting in around 13 extra manhours.
Methods to improve error detection	Visual management	Also by displaying the important parts of the process visually on a board to improve every day. [...] use the colours red and green in particular. [...] visual management to monitor your processes.
	5S	5S, for instance, are five steps in which you go from an unstructured workplace to a structured workplace and where you eliminate remove a lot of waste.
Methods to manage change	Team approach	One method we implemented is the daily stand-ups combined with daily planning. So you can see every day if the planning is achieved and if not then you have a kaizen, then you have something to improve.

Appendix 7 - Coding scheme - Enabling factors of lean interventions

Enabling factors of lean interventions	Element	Respondents quote
Hospital 1 – Respondent 5 – quality advisor		
Situation and organisation	Vision	A collective sense of urgency to improve something. The will to improve something.
	Vision	Explain very well what we are going to do and which approach we choose.
Characteristics of the intervention	Adaption	To not really call it a lean intervention. You notice that, and that is not the case for everyone, but people have some sort of aversion to the term lean. They often think that it is about decreasing the number of employees because we are looking at how to do it more efficiently. [...] but it is mainly about doing things smarter.
Local delivery process	Management	Not that many departments that use day starts very well. I think this has to do with how the board of directors conveys the message and that no hard label of lean is linked to it. [...] I see that it would help departments if we would do it.
	Teamwork	What we see, for instance when a value stream map is done at a department, often participants are very enthusiastic to go so multidisciplinary through their process and so thorough.
	Teamwork	So by doing a VSM with everybody involved [...] then you see a behaviour change. Participants are inclined to map the process again with a VSM the next time.
Sustaining long-term results	Supportive culture	Usually, we join as process supervisors and our suggestion is to first map the process with all people involved, this way support is created for a certain way of working. Then they also look from a joint starting point to how they can further optimize.
	Communication	Explain very well what we are going to do and which approach we choose.
Hospital 1 – Respondent 10 - Manager quality advisors		
Situation and organisation	Vision	Tight agreements at the beginning are incredibly important. [...] is this the goal that we want to realise, is this the result that we want to see. [...] but also about the time input.
	Vision	And what is also very helpful if it is not devised by a manager that we should do this for this reason, unfortunately, this is sometimes necessary, but especially from the people in the primary process.
Characteristics of the intervention	Resources	Time, room, budget, and commitment from the department. Real commitment from the people in the primary process to cooperate with it.
Local delivery process	Staff involvement	When you work with professionals, people really need to be motivated to improve something. [...] I do not want to say that we do not do it otherwise, because you can always make good agreements about where to start with the improvements. But preferably you start with the people that want it.
Sustaining long-term results	Supportive culture	Lean offers beautiful things to intervene in the culture [...] such as day starts, in which you discuss daily with each other what the day is going to look like, what do we expect from each other, which challenges do we want to tackle today, who is going to do that and when. Those are actually all interventions aimed at changing behaviour and realising improvement.
Hospital 2 – Respondent 6 - Programme coordinator		
Situation and organisation	External support	We are in the beginning and still supported by an external consultancy firm [...] they provide us with insights into how other organisations approached it and what they learned from it. [...] but it is also very important to work on securing it within your organisation.

Characteristics of the intervention	Training	I think most important is that we educate people. We offer multiple trainings such as yellow belt, green belt, lean leadership, and leadership for higher management because we see that the system depends on good leadership.
	Training	In addition to training, we link a sort of lean coach to a department. [...] to go from a deviation to an improvement, during the job we coach employees to achieve this. [...] because you can learn it one time in a classroom but then it is always much harder.
	Training	So by providing the training at various layers in the organisation and also all sides of the organisation we try to get it to a system. That people also start talking the same language.
	Training	We always provide, besides training in classrooms, support during the work. [...] top-down help in the first steps, but then also support to maintain in their department. This way, they experience a lot of support which is also beneficial for their learning process.
	Training	We also train leaders, for instance, team leaders or senior nurses who have a role as a leader in their department because they are very important for giving the people that we educated room to work on the improvements, to coach them, and to develop them.
Local delivery process	Management	I think most important is that we educate people. We offer multiple trainings such as yellow belt, green belt, lean leadership, and leadership for higher management because we see that the system depends on good leadership.
	Management	We have a core team that is a delegation from different layers of the organisation. [...] these are the ambassadors, and they, especially in the beginning, made people enthusiastic to start working with it. This way, we could achieve the first successes.
	Staff involvement	We never said that everybody, every department has to do it. [...] that does not really fit lean since it comes from the employees themselves instead of top-down.
	Administrative support	We always provide, besides training in classrooms, support during the work. [...] top-down help in the first steps, but then also support to maintain in their department. This way, they experience a lot of support which is also beneficial for their learning process.
	Management	We also train leaders, for instance, team leaders or senior nurses who have a role as leaders in their department because they are very important for giving the people that we educated room to work on the improvements, to coach them, and to develop them.
Sustaining long-term results	Holistic approach	So by providing the training at various layers in the organisation and also all sides of the organisation we try to get it to a system. That people also start talking the same language.
	Continuous improvement	We have a core team that is a delegation from different layers of the organisation. [...] these are the ambassadors, and they, especially in the beginning, made people enthusiastic to start working with it. This way, we could achieve the first successes.
	Continuous improvement	When there comes a new board, convince them that this is important in our organisation, where we need to pay attention to [...] or when there is a new manager that it is taken into consideration, or that physicians consider it when discussing issues.
	Supportive culture	We also train leaders, for instance, team leaders or senior nurses who have a role as leaders in their department because they are very important for giving the people that we educated room to work on the improvements, to coach them, and to develop them.
	Continuous improvement	We are in the beginning and still supported by an external consultancy firm [...] they provide us with insights into how other organisations approached it and what they learned from it. [...] but it is also very important to work on securing it within your organisation.
	Supportive culture	And celebrate successes, that is one thing that we continuously give attention to. [...] we tend to keep it to our self, but this way these successes are not always clear or people just do not see them which is very unfortunate.
Hospital 3 – Respondent 7 - Lean manager		
Situation and organisation	Vision	A clear strategy is desirable because you will notice that people will increasingly notice waste and potential improvements. [...] without a clear strategy you have no clear framework to make these decisions. [...] then everybody starts thinking about what they think is best and you still end up with siloes.

	Alignment	A clear strategy is desirable because you will notice that people will increasingly notice waste and potential improvements. [...] without a clear strategy you have no clear framework to make these decisions. [...] then everybody starts thinking about what they think is best and you still end up with siloes.
	Competence	Look beyond just lean and six sigma [...] without basic knowledge about change management, how do you get people involved and how to deal with resistance, projects get stuck very fast. [...] hospitals are, how should I say it, political organisations with quite complex power structures.
Characteristics of the intervention	Customer focus	The biggest motivation for people to work in healthcare is to deliver quality to patients. So, you notice that actually everything you do related to this motivates employees. They enjoy their work more because the care is improved.
	Resources	Also time and attention. What you often see is that people work full time and have these sorts of tasks additionally [...] then we now that it is not going to work or that it will take a lot of time.
	Training	Look beyond just lean and six sigma [...] without basic knowledge about change management, how do you get people involved and how to deal with resistance, projects get stuck very fast. [...] hospitals are, how should I say it, political organisations with quite complex power structures.
Local delivery process	Management	I think that support from management is most important. [...] they need to stimulate [...] you need to have a pool that actively asks questions about the status of projects.
Hospital 4 – Respondent 8 and Respondent 9 – lean coaches		
Characteristics of the intervention	Adaption	Sometimes we have teams that dislike the term lean. Then we try to avoid using it a little bit.
	Training	We always consider the soft side during training [...] so that is very much about attitude and behaviour
	Training	We had leadership training, which is a complete green belt training with a focus on the leadership role. [...] we linked a guidance course to this on the departments, we call that the lean in team’s course. [...] and we had separate green belt training mainly intended for people that work independently.
	Resources	A very important factor is also time available for it. For instance, in the guidance courses in a team, we indicated beforehand how much time it cost weekly.
Local delivery process	Management	We had leadership training, which is a complete green belt training with a focus on the leadership role. [...] we linked a guidance course to this on the departments, we call that the lean in team’s course. [...] and we had separate green belt training mainly intended for people that work independently.
	Management	Afterward, there was often less follow-up. People kept working in the same way as they did before, and had to motivate themselves to work with the lean tools. Sometimes managers even stopped employees and said they did not feel like working with A3 because they preferred the old documentation.
	Management	For the development of lean in the organisation, it is very important to have a separate team that is completely focussed on it. [...] that is also supported by the board of directors, to do activities and educate people.
	Administrative support	For the development of lean in the organisation, it is very important to have a separate team that is completely focussed on it. [...] that is also supported by the board of directors, to do activities and educate people.
Sustaining long-term results	Supportive culture	Celebrate everything that changes, that improves in the organisation and show it to everybody so that they inspire each other and that they can learn from each other.
Hospital 5 – Respondent 11 - Program manager lean/manager quality		
Situation and organisation	Competence	They became the trainers [...] they made sure that everybody understood what a fishbone was, or what a value stream map was, and what you can do with it. They linked homework to the training so that people started practicing and became curious.

	Competence	We also help them in understanding the eight types of waste.
Characteristics of the intervention	Training	We gathered a whole group of trainers around us internally. All colleagues who were working in different functions such as a physiotherapist, a mental health caregiver, nurses [...] we trained them [...] we really did that for three years with them.
	Training	75% of the employees are trained. All these employees have had basic training, or a yellow belt, or a green belt, and they know what the wastes are. So we get a lot of emails or requests in which they mention that they identified waste. They want to tell it proudly or ask for help.
	Resources	That I got the opportunity and trust to build. [...] that they did not complain about money.
	Training	We give basic training to physicians [...] consisting of me and an external physician, from another hospital. But he said that we surpassed their hospital by now, so we should choose a physician from our hospitals. [...] So they train their colleagues now.
Local delivery process	Staff involvement	One of the most important factors was creating step by step a core team so that you have a group of people in the organisation that does it together. [...] with the entire board of directors, not just a delegation.
	Management	One of the most important factors was creating step by step a core team so that you have a group of people in the organisation that does it together. [...] with the entire board of directors, not just a delegation.
	Management	That the entire board of directors is behind it, and the medical staff, and the staff board.
	Management	Shop floor visits from the board of directors, really going to the Gemba.
Sustaining long-term results	Supportive culture	Hospital-wide, nobody says what is a value stream map. [...] the works council, nursing advisory board, managers, physicians, if they discuss something and want to identify causes, I frequently see a fishbone being used.
	Supportive culture	By now, people do not get scared of those words anymore, and they do not think: What should I do with it? It actually became quite ordinary.
	Communication	75% of the employees are trained. All these employees have had basic training, or a yellow belt, or a green belt, and they know what the wastes are. So we get a lot of emails or requests in which they mention that they identified waste. They want to tell it proudly or ask for help.
	Supportive culture	If you talk about culture and working according to the same improvement language. [...] if I say fishbone to physicians, then, in general, it does not scare them. [...] in our hospital, 155 physicians voluntarily joined our training.
	Supportive culture	I come one time a week, the past half year three times a week, with the board of directors on the shop floor to the employees [...] to ask how applying the lean philosophy is going.
	Supportive culture	Employees particularly say the fact that I can do it myself, discover it myself, can make mistakes, that is what makes it so enjoyable.
	System-wide scope	In the selection procedure, you must know which people to hire. So, with the complete recruitment and selection of employees hospital-wide, but especially with key figures such as the board of directors, you have to secure maintenance.
	Continuous improvement	Another one is perseverance [...] do not think okay they do not want it. Let them go and determine a course. So that they will eventually get in trouble if they do not know anything about it or still haven't worked with it.
	Supportive culture	To not push impose it, at the same time set a framework. [...] you have to facilitate it in a way that people feel supported. So there must be training and people that are ready to help.
	System-wide scope	We have created a kind of base in the hospital of people who this continuously and carry it out.
	Communication	That you keep telling honest stories, they are not always stories of success. Some departments completely stop with it because their department head left.

Hospital 6 – Respondent 1 - Quality advisor		
Characteristics of the intervention	Resources	It also cost a lot of time, the lead time of such a lean improvement project was quite high. People thought that we could implement improvements more quickly.
Local delivery process	Management	But you see that, with certain management, it comes, is deployed broadly – we called it Lean Six Sigma – and then afterward it is less applied. Now, this is not talked about at all anymore in the hospital.
Hospital 7 – Respondent 2 – Business manager		
Situation and organisation	Vision	You must have the knowledge and also the feeling that it pays off.
	Competence	You must not only give people time to do it, but you also have to make sure that they know how to do it and you have to guide them in that, for instance, with a lean coach – people that know how to do this in the best way.
Characteristics of the intervention	Resources	That managers get the possibility to use it and that time is available.
	Training	To teach people to look at the problem in such a way
Local delivery process	Teamwork	The key is to involve people that know how to guide such a process, but they must not take over the job of the people that know the content. [...] take them by the hand, and guide them to come to the right solution.
Sustaining long-term results	System-wide scope	It has to be carried, broad throughout the organisation, in all layers.
Hospital 7 – Respondent 3 – Lean coach		
Situation and organisation	Competence	There were three points on which they wanted to improve [...] defining the problem, but also choosing a good change strategy [...] and maintaining results. So, for these points I made training.
	Competence	70% of the interviewees mentioned that they found it hard to actually improve things because most of the time they are the only ones with a lean certificate in their department, so with this we need some more help.
	Experience	That they can excite each other, everybody wants to be involved in such a value stream right now. That is the success that lean actually creates, which makes doing more complex projects possible.
Characteristics of the intervention	Customer focus	We always look at it from the customer's perspective, and that is usually the patient. We do a lot of projects on customer care, on patientcare.
	Customer focus	Lots of times there is a discussion about who has to do this, who has to register this, who has to observe this [...] this is always a nice topic for discussion. [...] when we agree on that by doing this, we can deliver better patient care, then the discussion is resolved. [...] then we can look at what is the most convenient and clever method.
	Adaption	A healthcare professional is of course very autonomous and also educated that way [...] the word standardisation used on the training [...] that is not a term that makes professionals excited for lean. So, we do not use the word standardisation. [...] of course we use it because they also read it in literature, but then I always make an example from it.
	Customer focus	But also, patient-centered is not always self-evident [...] Because then you have an abstract patient. If the patient is in front of him, then everything revolves around the patient. But if you talk about the patient, then it is difficult. [...] For this you need people on the sideline, who ask that question every time and shift the focus to this.
Local delivery process	Management	They also gave a clear signal that we have to do it more structured and more top-down. Not just bottom-up, the low hanging fruit.
	Management	Therefore, we started with training the whole management team [...] we want that also the managers understand the lean ideas, and that they facilitate and stimulate this to employees.

	Management	If we do a big project, with a3, with a frame, then I find a steering group a success that has all the projects listed together and now what is going on.
	Staff involvement	But eventually is it a self-fulfilling prophecy because people want to experience it themselves and then share these experiences. And then others want to participate as well.
	Staff involvement	Have you ever seen someone with a delirium [...] we have to really make sure that patients do not incur a delirium [...] Those are the inspiring stories, the excitement, and the urgency that you have to create to get a healthcare professional to cooperate.
Sustaining long-term results	Measurement	You want to measure the interventions that are performed, resulting from a check, and "celebrate" this [...] because this is where you are there for as a nurse.
	Communication	Also sharing the small things with each other in the department – learning with and from each other. Lean offers a platform for that, through a day start for instance.
Consultancy firm – Respondent 4 – Lean consultant		
Situation and organisation	Vision	An important one is that you have to create support within the organisation. That people see very clearly why they do it. And for this, it is important that the organisation clearly explains what the goals are and what the organisation stands for. And that can be on high-level mission, vision [...] and translate that to goals per department.
	IT-systems	I also think that it is nice to have a flexible environment. [...] if you want to do software changes, that it can be done more easily [...] and that sometimes you can do something quickly too, for instance, test it.
	Competence	And of course, the prerequisite that everyone understands what it is about, that you give people knowledge in general and that you explain what it is about. [...] otherwise people think it is just a trick that you use once and then we are done with it.
	External support	In some cases, make use of external support to help you with it.
Characteristics of the intervention	Training	Give employees insight into their own processes. And we do that with something like a game to learn people how to look at a process [...] the green activities create value and the red activities do not create value.
	Training	Training, give people the opportunity to read things through, make sure that knowledge is available internally so that you can help people, and can coach them. [...] training on methods, how to do 5S, how to do VSM. But also on how to coach people, how to handle the team, how to motivate people.
	Resources	Make sure, especially in the beginning, that there can be investment in improving. [...] and that can be by making extra capacity available, or by sending people to training, making time for it.
Local delivery process	Management	Very important is that management, direction, fully support it. That they see the usefulness of it and that they also do something with it themselves. [...] that they facilitate the work floor in improving their processes.
Sustaining long-term results	Supportive culture	Important is that you create safety in the organisation. [...] that you do not have a blame culture [...] that you say I am glad you reported this mistake because now we can actually improve it.
	Holistic approach	So you go in a stepwise approach through the whole organisation, where you learn every group-specific thing about how they should change to reach the whole lean philosophy.
	Measurement	Also by displaying the important parts of the process visually on a board to improve every day. [...] use the colours red and green in particular. [...] visual management to monitor your processes.

Appendix 8 - Coding scheme - Lean thinking outcomes

Lean thinking Outcomes	Element	Respondents quote
Hospital 1 – Respondent 5 – quality advisor		
Hospital performance	Time savings	At the intensive care, for instance, they use an improvement board for their incident notifications [...] by discussing this together daily they solve these incidents much faster.
	Throughput time reduction	Sometimes it is indeed about throughput time reduction.
	Quality improvement): Sometimes it is also about quality; for instance, for an accreditation label, just that extra step to map the care path so that it is not just in the heads of the employees but also on paper.
Development of employees and the work environment	Learning ability	Learning ability is also much higher than when a separate system that is aimed at individuals is used, especially with visual management and discussing it with each other.
	Job satisfaction	What we see, for instance when a value stream map is done at a department, often participants are very enthusiastic to go so multidisciplinary through their process and so thorough.
	Proactive attitude towards problem-solving	So by doing a VSM with everybody involved [...] then you see a behaviour change. Participants are inclined to map the process again with a VSM the next time.
	Team cohesion	Sometimes it is approached a bit differently. Then it is more about team spirit and teamwork.
Hospital 2 – Respondent 6 - Programme coordinator		
Hospital performance	Patient satisfaction, Communication	For instance, patients are more satisfied with the process because after the nursing department they can go home because we improved the process in a way that the patient has more influence.
	Throughput time reduction	That patients can be seen sooner, so shorter waiting time at our policlinics
	Reduction of errors	More often first-time rights.
	Throughput time reduction	Less waiting time between appointments.
	Communication	More attention to the voice of the patient; for instance, they can talk to us about what they find important when they are hospitalised.
	Throughput time reduction, Reduction of errors	Another example is where a patient had to wait six weeks for his treatment. [...] and sometimes the appointment was even cancelled on the same day because we did not have the right materials ready. [...] we reduced this to two weeks and where everything is right the first time.
	Time savings	5S is one of those methods we use to organise the workplace so that people lose less time searching in their jobs, because we cannot use the time we spend searching or replenishing materials on our customer or our patient.
Development of employees and the work environment	Job satisfaction	What we see a lot is that the job satisfaction of the employees increases.
	Learning ability, Job satisfaction	You also see that it improves the learning culture and that this happens during the work and that it also contributes to keeping people in the organisation.
Hospital 3 – Respondent 7 - Lean manager		
Hospital performance	Cost savings	We had problems with damage to the scopes used in the endoscopy [...] the cameras are very fragile, and we had around 10,000 euro's damage annually [...] made a picture of how the scope had to be placed in its container [...] the picture is now standard in the container and you put the scope on top of it.

	Quality improvement	Very much is about quality of care. [...] it is also about whether patients are well prepared for their examination [...] how many times is the medication actually not taken or should have been taken [...] often the examination could not be done or the results were influenced.
	Throughput time reduction	Or about throughput time [...] how long does it take from the first visit of the physician until the first diagnosis, and can we decrease that.
	Balanced workload, Time savings	A lot has to do with workload, how can we decrease the administrative burdens, and can we increase the care time.
Development of employees and the work environment	Job satisfaction	The biggest motivation for people to work in healthcare is to deliver quality to patients. So, you notice that actually everything you do related to this motivates employees. They enjoy their work more because the care is improved.
Hospital 4 – Respondent 8 and Respondent 9 – lean coaches		
Hospital performance	Planning improvement	One nursing department noticed that they could not determine the discharge in advance [...] Eventually we did a value stream analysis for this process and we noticed that there were various standard tasks [...] this appointment is now planned at the same time when the operation is planned. [...] so the patient can go home at eleven o'clock the next day.
	Planning improvement	We just received some results about the expected discharge dates. This is very important for making a good planning for the nursing departments [...] that used to be known and filled in for 40 percent and now we are at 90 percent.
	Quality improvement	For example, in the dialysis department, the number of patients that were connected on time was somewhere around 40 or 50 percent, and now already around 90 percent.
	Communication	In the emergency department patients gave us feedback that they sometimes did not know where they were waiting on. [...] we did a project in which every patient is seen within ten minutes by a nurse. [...] with a colour system we differentiate between patients with severe injury and less severe injury.
Development of employees and the work environment	Job control, Team cohesion	We did a project where employees can decide themselves what they wanted to improve. Usually, it had something to do with the coordination of work and teamwork. And doing a day start actually already helped a lot with this.
	Communication	Information provision, for instance from managers to employees, also improved on certain departments and also that they now exactly know which tasks are completed so that you do not have to check or ask questions.
	Job satisfaction	We just evaluated with all the people that we educated with a green belt [...] everybody mentioned that their job satisfaction increased with the use of lean.
	Job control	I notice that it also offers some structure. They mention, for instance, that it is nice to work with A3 to keep your project in control.
Hospital 5 – Respondent 11 - Program manager lean/manager quality		
Hospital performance	Planning improvement	Physicians came up with an idea to improve hospital discharge because physician visits took too long [...] can we do a five-minute stand-up meeting – no substantive information about the patient, but, according to a certain structure, look at which patients are there and who can be discharged? This way, patients know at nine o'clock in the morning that they can go home at three o'clock.
Development of employees and	Job satisfaction	Our employees' satisfaction increased [...] hospital-wide, lean is among the top three things they are most proud of.
	Proactive attitude towards problem-solving	If you talk about culture and working according to the same improvement language. [...] if I say fishbone to physicians, then, in general, it does not scare them. [...] in our hospital, 155 physicians voluntarily joined our training.

the work environment	Job control	They mention that they experience more control over their work by working with lean.
	Job satisfaction	Employees particularly say the fact that I can do it myself, discover it myself, can make mistakes, that is what makes it so enjoyable.
Hospital 7 – Respondent 2 – Business manager		
Development of employees and the work environment	Team cohesion, Proactive attitude towards problem-solving	During a day start, you can discuss in ten minutes what has to be done today, [...] make sure that you can do your job better and that the team building becomes stronger. [...] if you discuss it beforehand and divide the work, then a lot more cohesion and willingness to work is developed.
Hospital 7 – Respondent 3 – Lean coach		
Hospital performance	Time savings	A pharmacy assistant was scheduled to take care of the medication administration for new patients. [...] five half days a week, an assistant was doing this, and can you imagine this was for 300 patients a year. [...] they were constantly working six weeks ahead [...] what value do you deliver your patients and that turned out to be only 24 hours before. [...] we decided to make it visual through a daily planning list, on which you can check if there will be new patients tomorrow and then perform the actions.
	Reduction of errors	Plus the number of patients that we missed is reduced to zero because we continuously check this through the daily planning.
	Patient safety	We made it safer for the patients because the checks and the records, for instance about the contraindication, are registered more logically before medication is released.
Development of employees and the work environment	Communication	But the nicest result of such a value stream session is that the grumblings among people stop. [...] now I get what all the fuss over this process and the checkmarks is about, okay, so how can we improve the patient care? And let's look at the process from another perspective.
	Communication	Visualizing such a value stream results in conversations with each other, it results in understanding, and it results in a look back. [...] I always trust that eventually there will be more attention for neatly filling in the checkmarks for the observation. [...] that was the reason and that was the goal [...] but for me, that is not the success of the intervention.
	Job satisfaction	We linked a survey to it, questions to people who we gave a greenbelt training. [...] But despite that our job has become enjoyable, because we look at things differently and because we can help people by asking questions like how do we know that we have a problem.
	Proactive attitude towards problem-solving	For us, the behaviour that is needed for continuous improvement is what we want to achieve. That everyone pays attention to that, how can I do a better job tomorrow. And in this we already made big steps, that is where I am proud of.
	Job satisfaction	But despite that our job has become enjoyable, because we look at things differently and because we can help people by asking questions like how do we know that we have a problem.
	Job control	And apparently also more control over their work by having much more understanding of how such a value stream works. Then, they can much better imagine how it goes outside of their department.
Consultancy firm – Respondent 4 – Lean consultant		
Hospital performance	Throughput time reduction	We made a VSM and it turned out there were 36 or 37 steps to set to invoice to payable [...] we looked at which process steps were really needed in the process [...] and through innovation and kaizens we brought this process back to seven steps. And with this the throughput time from 38 days to six days.

	Throughput time reduction	To switch from working in a batch approach on the lab where you collect material at one moment [...] to a one-piece flow where materials are used every minute. [...] And with this we brought the throughput time with an average of 65 hours back to within six hours and with a second step even to within three hours.
	Cost savings	Afterward, kanban is also implemented hospital-wide. And this also reduced the inventory a lot. [...] a huge amount of inventory value was reduced in the hospital.
	Time savings	By implementing kanban in the lab, and not working with order lists anymore, resulting in around 13 extra manhours.
	Time savings	They did not have to walk back to the gathering place. [...] on walking and searching they saved around 580 hours per year that could be used for quality and extra cleaning.
Development of employees and the work environment	Time savings	What we also did was to organise the process differently so that people had to walk less. [...] we reduce this from 500 to 25 pieces which made it possible for the department to order it themselves and the nurses did not have to walk down each day or a few times a week.
	Balanced workload	Fewer peaks and troughs when working in the department. So that your work has a better flow. That, of course, gives the employees the result of a better-balanced workload throughout the day.
	Learning ability	More insight into their own processes through which they could better see where to improve.
	Job satisfaction	You could notice that throughout the hospital, I do not say that everyone felt this, but you could notice like, I notice that I have more joy in my work and that I have more time over for my patient or more time to create value for my patient.
	Job satisfaction	People are willing to work, also to work hard, but then they want to work on something that is value, that delivers results, that is important for the patient. [...] so if you can convert your time into value and remove the red time, the waste, then you get more enjoyment in your work.