Lean healthcare in Danish Healthcare Organisations

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MAY 2015
Executive summary

This thesis compares two public Danish healthcare organisations, Hillerød Hospital (HH) and Odense Universitetshospital (OUH), in their attempt to successfully implement Lean healthcare. The first Lean project was piloted in 2004 at HH and continuous learning is still an important part of the strategy.

The purpose of the thesis is to identify, what Lean healthcare is and how it differs from Lean manufacturing. Furthermore, the thesis seeks to analyse the differences and similarities HH and OUH faces, when trying to implement the Lean strategy. Lastly, the thesis reflects on how to secure continuous learning and discusses, whether Lean healthcare is suitable for Danish healthcare organisations and how it should be applied.

The thesis is based on a qualitative business research, with a deductive approach, which bases case studies on existing strategy originally developed by Womack and Jones (2003), Liker and Meier (2006) and later extended by Wickramasinghe et al. (2014). The purpose is to identify difficulties and suitability, when a service organisation implements a Lean strategy originally developed for the manufacturing sector.

The value perception is the same in Lean healthcare as in manufacturing settings. Value is what the costumers perceive as value adding to the products or services they demand. The value stream divides treatments into product families, which are then mapped in order to reduce waste, similar to the manufacturing sector. The flow model used at both hospitals is single-piece flow, which is also similar to the manufacturing sector. The healthcare sector focuses on information flow rather than process flow, which is significantly different from the manufacturing sector. To make flow successful the primary Lean tools such as: 5S, Spaghetti diagrams and the SMED model have been implemented at both hospitals. Rather than pulling products through the processes, the healthcare sector pulls work assignments and use scheduling to accommodate how flow is dealt with at both hospitals. Perfection is obtained similarly in the manufacturing- and healthcare sector, namely by using Kaizen meetings.

The evidence suggests that Lean can successfully be applied to the Danish healthcare sector. The implementation of Lean was however different in the two organisations. Even though they chose different implementation strategies Lean yielded positive results in both organisations.
Implementation of the Lean strategy in Danish healthcare organisations is still young, which means continuous learning is still at its early phase. To secure continuous learning in the long run, Danish healthcare organisations could apply other Lean philosophies such as TQM, which emphasises on Lean tools that have not yet been implemented at HH and OUH. The hospitals have however implemented other Kaizen tools such as: Education and Lean consultants to secure continuous learning in the long run.

When implementing Lean in a Danish healthcare organisation it is important that the different layers of the organisation accept the new strategy. In Denmark the hospitals follow a top-down approach. The operational level is the most important level when leading for change. While Lean cannot succeed without support from the operational level it can succeed without support from the board and the government. When applying Lean healthcare it is therefore of highest importance that the workforce at the hospitals accept the Lean vision and embrace it. The thesis concludes that Lean is suitable in Danish healthcare organisations, but as in the manufacturing sector, it is not unnatural to face implementation difficulties.
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Appendix
1. Introduction

It is becoming increasingly important that the public hospitals run smoothly in Denmark, because of increasing pressure. Not only are the costs of running hospitals increasing, the patient activity is also increasing (Regioner, 2014). According to Regioner (2014) 95 out of 100 individuals make a visit to the local hospital every year, and the general activity of hospitals has increased by 30% from 2006 to 2012 (Regioner, 2014). Danish hospitals generally have scarce resources, concerning both doctors and equipment (Rasmussen, 2014). Therefore it is critical that these resources are utilised to the maximum and that idle times are minimised. If these scarce resources are not allocated optimal it might course fatalities, which must be considered the ultimate sacrifice for a hospital.

These problems might be solved with the right use of Lean healthcare. The purpose of the Lean healthcare strategy is to utilise the resources available with the costumers in focus, and not to cut costs. The goal is to get the highest possible patient perception of the public healthcare sector, and to allocate those scarce resources most efficiently; an advantage might be that the costs of running a public hospital decrease.

Having shed light upon these issues it is interesting to investigate what Lean healthcare is, and how the strategy is implemented in Danish healthcare organisations. Furthermore, it is important to learn how to sustain this strategy in the long run and how Lean healthcare should be applied and whether it is suitable in public Danish healthcare organisations.

1.1 Problem Statement

Lean healthcare is a specific form of Lean Thinking, which is different in the sense that healthcare organisations are part of the service sector, in contrast to the origin of manufacturing organisations. The main purpose of the strategy should remain the same: to secure continuous learning, eliminate waste and create value for customers. It is interesting to investigate what Lean healthcare is, and how it differs from the original Lean Thinking.

Traditionally healthcare organisations do not put the customer first but instead focus on the management of the organisation (Womack and Jones, 2003). This strategy has resulted in long queues of patients and as a consequence reduced perceived value. At
the same time, this has also resulted in waiting time for e.g. doctors (Wickramasinghe et al., 2014). This is an issue for patients since it can leave them frustrated and in worst-case scenario end in fatality. It is also an issue for healthcare organisations since resources might not be allocated optimal in order to minimise costs. Reallocation of resources could potentially instead be used for developing new cures (Womack and Jones, 2003). A way to solve these issues could be to implement the Lean healthcare strategy. Therefore, it is important to know how to implement the strategy and how it will affect a healthcare organisation.

One thing is to implement the strategy, but more importantly, an organisation needs to secure that the strategy is continuous upheld. Lean might evolve around a complete cultural change within the organisation and processes need to evolve around continuous learning in order for the strategy to be successful (Liker & Meier, 2006). It is vital to reflect on how continuous learning can be secured in public Danish healthcare organisations in the future.

The implementation of Lean healthcare in public Danish healthcare organisations has only begun quite recently. Pilot projects finished at OUH by the end of 2007 where the rest of the departments at the hospital started to implement Lean healthcare (Odense Universitetshospital, 2007). At HH the first Lean project finished in 2004, which led the way to implement Lean healthcare in several other departments in 2006 (Bak-Berth & Vinterberg, 2010). The implementation being so recent, continuous learning has not been upheld for very long. This fact makes it interesting to reflect upon how Lean healthcare should be applied and whether it is suitable for public Danish healthcare organisations.

1.2 Research Questions

1. What is Lean healthcare?

2. How is Lean healthcare implemented in Danish healthcare organisations?

3. How should continuous learning be secured in Danish healthcare organisations?

4. How should Lean healthcare be applied in Danish healthcare organisations?
1.3 Literature Review

The focus of this thesis is a qualitative business research of two Danish healthcare organisations through a deductive approach, meaning that our research questions and topic is based on existing theories and prior research.

Our research is based on strategies introduced by Womack and Jones (2003), Liker and Meier (2006) and Wickramasinghe et al. (2014). Furthermore, our research questions are answered by using experiences from Bak-Bernth and Vinterberg (2010) and Odense Universitetshospital (2007).

Womack and Jones (2003) is a book that focuses on adding empirical evidence to a new framework. The findings entail data from multiple companies in North America, Europe and Japan. The book uses simple tools to create lasting value in any business. It seeks to explain how to apply these tools step by step in both small and large businesses. The study used is an extensive longitudinal case study, where primary data has been collected over a nineteen-year period. Fifteen years of benchmarking companies around the world, before presenting the Lean framework, and four years of extensive triangulation to test the framework. The extensive case study consists of multiple cases aiming to test an extend theory by comparing multiple organisations. The extensive case study is consistent with way Womack and Jones (2003) have approached their research. The advantage of extensive case study is that multiple data sources are collected. The disadvantage is that multiple data sources can be shallow and less detailed. Womack and Jones (2003) demonstrate that Lean can be implemented in different industries including service companies. They apply a hands-on approach, where they act as both insiders and outsiders. This approach is called practical researcher participation, within action research. Action research is appropriate if the object is to understand change, development and improve some actual problem, which fits well with the work of Womack and Jones (2003). The book emphasises that companies can choose not to have their research published, meaning that bad results might be withdrawn from the findings.

Liker and Meier (2006) is a field book conducted on empirical evidence from Toyota. It entails ten years of employment experience in the Toyota organisation and twenty years of research in corporation with Toyota. The book uses several concepts within the five principles that were originally introduced by Womack and Jones (2003). It emphasises on changes at Toyota, and how to apply Lean to other organisations. Liker and Meier
(2006) use an extensive longitudinal case study, which contrary to Womack and Jones (2003) which started with an intensive case study that led to an extensive case study of applying the strategy to other different organisations. The problem with this intensive case study is that they do not have multiple data sources, but the advantage is that they have deeper and more detailed data. They turned the disadvantage of intensive case study by using triangulation in the extensive case study. The book uses both real and fictive cases, which consist of both manufacturing – and service companies. Similar to Womack and Jones (2003) this book also uses a hands-on approach, which is action research. It is not stated in the book whether or not some findings has been withdrawn from the book.

Wickramasinghe et al. (2014) is a book, which focuses on combining a wide range of issues related to efficiency and quality in healthcare, through application of the five principles introduced by Womack and Jones (2003). It introduces key concepts, tools and techniques in American healthcare organisations and the differences moving from manufacturing – to healthcare settings. Wickramasinghe et al. (2014) uses longitudinal and cross-sectional extensive case study where different healthcare organisations around the world, are used to test and extend the Lean thinking strategy to healthcare organisations. The primary data in the book is collected when analysing case studies and throughout the rest of the book secondary data is collected mainly through prior research. Using a cross-sectional design promotes reliability and generalisation and combined with a longitudinal design it takes into account the process of implementing Lean over time. Regarding the case studies the book uses action research similar to Womack and Jones (2003) and Liker and Meier (2006). The research results in an extended framework of the five principles of Lean.

Bak-Bernth and Vinterberg (2010) is a book that is written by two full time Lean consultants at HH. It emphasises on presenting, which Lean tools were successful at HH by implementing the five principles of Lean. The study used is a longitudinal intensive case study with primary data from HH. It is intensive because HH was the first to implement Lean healthcare in Denmark. It entails experiences with Lean in different departments at the hospital. The Lean consultants used an inside action research approach, and exclude findings where Lean was not successful. It was published in 2010 and the data collection started in 2004.

Odense Universitetshospital (2007) is a report written by Lean consultants employed at OUH and the executive board. At OUH they use the three pillars of Lean, which is based
on concepts originally developed by Womack and Jones (2003) and Liker and Meier (2006). The study used is a longitudinal extensive case study with primary data from OUH. Experiences have been gathered from different departments, which have implemented Lean within the hospital. The Lean consultants use an inside action research approach. It is not stated in the report, that any findings have been excluded. The report was published in 2007 and the first pilot was aired in 2006.

The literature used in the thesis seek to determine whether or not the empirical strategy originally developed by Womack and Jones (2003), Liker and Meier (2006) and later extended by Wickramasinghe et al. (2014) can be applied to Danish healthcare organisations and yield reliable and valid results. The findings from HH and OUH will be critically measured against the developed and extended strategy. Furthermore, regarding the young age of the literature concerning Lean implementation in Danish healthcare organisation, it is not yet proven that continuous learning is secured in Danish healthcare organisations. Lastly, the literature will help answer the question of, how Lean healthcare should be applied in Danish healthcare organisations.

The rest of the references throughout the thesis are only used to support other minor arguments and will therefore not be more thoroughly evaluated in this section.

1.4 Methodology

This thesis is a qualitative study based on secondary data, which are primarily scientific articles, reports and books. This approach has been chosen to deductively test whether or not Lean can be applied to the healthcare sector. The empirical data will consist of reports conducted by the in-house Lean consultants at HH and OUH. These two hospitals have been chosen in order to compare how Lean healthcare has been implemented in both organisations, and which Lean tools have been applied. Furthermore, these two healthcare organisations has been chosen because these are the first to have either implemented Lean healthcare in the Danish healthcare sector or have run Lean pilot projects in selected departments of the hospital. The outcome of HH and OUH will be compared to the strategy of Womack and Jones (2003), Liker and Meier (2006) and Wickramasinghe et al. (2014), to examine whether or not the strategy can be applied to the Danish healthcare sector. This is an extensive case study, where the object is to: compare, investigate, elaborate and explain. This is done by cross-case analysis. The analysis aims to reveal similarities and make differences transparent. With a study of
only two healthcare organisations it is difficult to replicate the study and to generalise it to other hospitals.

The thesis is structured in the following way: The first section describes what Lean healthcare is and how it differentiates itself from the five principles of Lean originally developed by Womack and Jones (2003) and Liker and Meier (2006). There are some particular differences comparing Lean manufacturing and Lean healthcare. It is important to distinguish between these in order to analyse how Lean healthcare is implemented in a Danish healthcare organisation. This will be the descriptive part of the thesis.

Next, the collected empirical data is analysed. The analysis is centred on the five principles of Lean, which are also applied in Lean healthcare. In the section Value the customer is segmented, and value is determined. In the value stream product families and value stream mapping have been used. Both HH and OUH use these two Lean tools. The purpose of the analysis is to shed light on, the strengths and weaknesses of the models when applied to the healthcare sector. The section, flow, will be analysed using single-piece flow, which both HH and OUH are using. Here Liker and Meier’s strategy will be held up against Wickramasinghe’s strategy as well as the practical application of Lean at HH and OUH.

The models used in this section are the following: The 5S model. The advantages of this model are that it is easy to use, and it offers a good way of standardising processes. The model also works well with other models used at both HH and OUH. HH has used Spaghetti diagrams but this tool was not implemented at OUH. Both hospitals have adapted the SMED model. The SMED model gives the advantage that it tries to reduce changeover times, which have been a problem at both HH and OUH. The strength of these models, simplicity, can also be a weakness. Both hospitals have scarce resources. Introducing these models will not solve these problems. The section, pull, has not been given much attention at HH and OUH. This principle is also the one that deviates mostly from manufacturing to the healthcare sector. In the healthcare sector assignment of employees is pulled rather than the product. The last part of the analysis is perfection. Models used here are mainly Kaizen meetings. Kaizen meetings deal well with implications that arise on the operational level. Kaizen meetings may however not be sufficient when problems arise due to organisational changes at the executive- or public level. This will be the explanatory part of the thesis.
Following the analysis is the normative part. To secure that continuous learning is upheld several other Lean tools will be evaluated. These consist of: TQM, Performance Scorecards, Lean Audit, Process Owner, Lean Education, Lean Ambassadors and Lean Network.

The last normative part of the thesis is based on the different tiers in Danish healthcare organisation. The three tiers are: the top management, the middle manager and the workforce at the operational level.

1.5 Delimitations

This thesis will only deal with Danish healthcare organisations, which have already implemented Lean healthcare in either, the entire organisation or sub departments of the organisation. Furthermore, it will only concentrate on public hospitals thereby eliminating focus on private hospitals and smaller medical centres in the suburbs. The reason for this is, that private hospitals require that the patients pay for their treatments and that smaller medical centres are often too small to gather secondary data from.

Danish healthcare organisations are furthermore delimitated to HH and OUH.

Patients are more thoroughly defined in Section 4.1.1, and are regarded as Danish citizens. This means that foreign citizens are not taken into account since they have to pay for their own treatments.

Lean tools that will not be part of the thesis are Six-sigma, since this requires more primary data in order to statistically analyse performance. Furthermore, Just-in-time (JIT) and Total Product Management (TPM) will not be included in the analysis since JIT is centred on inventories and TPM is a tool that seeks to make equipment more efficient whereas the focus of this thesis is on information flow

Jidoka is not covered in this thesis even though it ensures that conditions are met before beginning a process. It is assumed to be present at Kaizen meetings, but the literature does not cover it more thoroughly.

The seven kinds of waste are only implicitly covered in this thesis. Waste will be identified in each principle throughout the thesis as they occur.

In the reflective part of the thesis, TQM will only be briefly dealt with due to the limited extent of the thesis.
1.6 Thesis Outline

The outline of this thesis is three-fold, consisting of: a descriptive part, an analytical part and a reflection. The outcome of the findings in the different sections will be summarised in the conclusion.

Figure 1 Thesis Outline

Source: own composition
The descriptive part consists of section 2 and 3, where Lean and Lean healthcare is described. The analytical part, section 4, is an analysis of how HH and OUH have chosen to implement Lean healthcare. Flow and pull is analysed separately for HH and OUH, because flow is the largest part of the analysis and dividing this section between two different hospitals will result in a better overview. Pull is also divided into two parts, because it is closely related to flow. The other three principles are not divided, because of the less magnitude and the fact that they share a lot of similarities. The last parts of the thesis are section 5 and 6, which is the reflective part and section 7, which is the conclusion.
2. What is Lean

2.1 History of Lean

The very first manufacturing production processes originate back to 1913 (Lean Enterprise Institute, 2015). It was at the production site Highland Park, MI, where Henry Ford fully integrated the production processes. This meant that production was split up into smaller processes, allowing personal and machinery to specialise their working process (Lean Enterprise Institute, 2015). The advantages of this were that a vehicle could be assembled within a few minutes, and that the components fitted perfectly side by side (Lean Enterprise Institute, 2015). As a result cars that came out of the Ford factory was of much higher quality than the domestic competitors, who were still using a single process production (Lean Enterprise Institute, 2015). The other manufactures used general machineries to produce cars, where components of questionable quality made it into the cars (Lean Enterprise Institute, 2015). Henry Ford was also able to turn his inventory very quickly - in a matter of few days. What he missed to realise was a changing demand from the public. The Ford Model T was the only vehicle produced at Highland Park, MI, at that time (Lean Enterprise Institute, 2015). It only came in one colour, and there was no possibility for costumer specifications (Lean Enterprise Institute, 2015).

Other car manufactures across the world realised the changing request for colour variety, but their production processes could not match the production process at Ford, which meant much higher costs and longer throughput time (Lean Enterprise Institute, 2015). The car manufactures tried to solve this by applying more machinery and making employee’s work faster (Lean Enterprise Institute, 2015). This eventually also lowered the costs of production, but increased the inventories and throughput time. This meant that there was a large downtime between processes, because they were not coordinated (Lean Enterprise Institute, 2015). The information system of the factories was too crude and could not comprehend to complexity of the task (Lean Enterprise Institute, 2015).

Kiichiro Toyoda and Taiichi Ohno looked at the situation after World War II, and decided to adopt The Ford Way of producing but with modifications. They wanted a continue flow of processes and create variability in the products, to accommodate the changing request for deviation in cars offered in the marked (Lean Enterprise Institute, 2015). The goal at Toyota was to fully utilise all machinery at all times. The conclusion
was seizing the machines to only produce what was demanded. Furthermore, machines were self-monitored to ensure that a high quality was obtained. Lastly, they made the process follow a certain sequence, to ensure that there was no idle time between processes. Essentially this meant that Toyota was able to sustain low production costs, high quality and quick turnaround of their inventory, to match the changing demand of the world. (Lean Enterprise Institute, 2015)

The emphasis of the Toyota way was a shift from a production focus of Henry Fords to a costumer focus of Kiichiro Toyoda and Taiichi Ohno. What they essentially came up with was (Lean Enterprise Institute, 2015):

- Specifying what costumers perceive as value adding. The world wanted larger variety of cars, which Toyota provided them with.
- Identifying value stream for each of their different products. Hereby the different cars that Toyota produced at the time.
- Making the product flow continuous in order to: ensure high quality, low production costs and quick turnaround of inventory.
- Introducing the pull system, where orders are pulled through the system and not pushed onto the costumers as with Henry Ford's way.

Even 60 years after the first introduction of Lean, Toyota still excels over many of their competitors in the car manufacturing market. In 2004 Toyota broke out a record year with earnings of 10 billion dollars making them the most profitable company in Japan's history (Liker & Meier, 2006). In 2005 the positive trend continued for Toyota breaking even more records, and managing to gain market shares where competitors were struggling to earn profit and was losing market shares (Liker & Meier, 2006). In 2005 Toyota won the covered J.D Power Initial Quality Award with first place in 10 out of 18 categories (Liker & Meier, 2006). Today Lean is not only applied to the car manufacturing industry, almost every industry and company can adapt to the Lean strategy (Liker & Meier, 2006).
2.2 The Five Principles of Lean

The main purpose of Lean Thinking is to reduce waste. Whether it is within the firm or in the downstream or upstream activities. Waste is characterised as activities that do not create value called Muda in Japanese, which directly translates to waste. These non-value adding activities are among others: reducing inventory, removing unnecessary processes, reassign employees from places of activities with no purpose to activities with purpose and services which do not create customer perceived value (Womack & Jones, 2003).

Lean Thinking centres on the philosophy of doing more with less. This means using less labour, less machinery on less space with less time, while becoming better at providing customers what they desire. At the same time Lean, also focuses on doing things right the first time and thereby turning waste into value (Womack & Jones, 2003).

Lean has evolved from only focusing on manufacturing settings to being a strategic tool that can be applied in every organisation across the world, since the introduction of the five principles of Lean by James P. Womack and Daniel T. Jones in 1996 (Hines et al., 2004). These five principles are: value, the value stream, flow, pull and perfection and are visualised in Figure 2. In the following sections, these principles will be described.

Figure 2 The Five Principles of Lean

Source: [http://wwwLEAN.org/WhatsLEAN/Principles.cfm](http://wwwLEAN.org/WhatsLEAN/Principles.cfm), 2015
2.2.1 Value

Value is the first principle and is therefore a critical step for Lean thinking (Womack & Jones, 2003). It can most easily be characterised as costumer needs and preferences, and only makes sense when it is a specific product or service that meet the costumer's needs. Creation of value is happening at the producers turf from the very beginning of the design process to the final launch of the product or service. It is important that the main focus is the costumer, and not existing assets or technology since main focus on the latter will create waste instead of reducing it (Womack & Jones, 2003).

Creating value might revolutionise the way an organisation does business. The first thing to do is to criticise the traditional way of perceiving value. The traditional way is, to create products by using machinery and thinking patterns that already exist within an organisation, instead of being innovative and thinking outside the box, and most importantly being in dialogue with the costumers. Traditionally the producers only make small adjustments to already existing products, which they hope that the costumers want. By being in direct dialogue with the final costumer an organisation can ensure that, they are creating what the costumers request from the start of the design process (Womack & Jones, 2003). Value can be hard to identify, since it varies with the different processes in different organisations. Furthermore, value might not only be specified within an organisation, but can be a part of a complete buying situation. An organisation might only consider about their given product or service, and not if the product is a complementary product from a prior buying decision made by the costumer. The costumer might have waited in line, when buying the first product and has to wait in line again to buy the next product etc. This could happen when going on a holiday, where the costumer needs to: Take the bus to the airport, take a plane to a foreign country, take a shuttle bus in the foreign country, before reaching the hotel where they have to wait to get the keys for their hotel room. This result in a lot of waste, related to queuing and waiting time, which is not satisfactory for the costumer. An organisation need to see the bigger picture and might need to create alliances along this vertical network to satisfy the costumer, when buying a whole product, where the costumer has to go through many different organisations before having purchased or consumed the whole product (Womack & Jones, 2003). Having rethought value it is important that an organisation challenges its new ways of defining value, to discover whether the findings are really the best way to create value for the costumer. This
process of constantly challenging processes is called Kaizen and will be described in section 2.2.5

Having defined value, and thereby having defined the product the last and most important element in value is, determining the target cost. This should be based on, how much resources and human capital need to be put into a specific product, when all obvious waste is removed from the process. The traditional way of price setting is to think of, what the market can tolerate and then determine acceptable costs. Lean enterprises (see Section 2.2.2) work differently. They ask what the waste-free cost of the product is, once value is made to flow and this becomes the target cost for all the activities for a new product. This result in lower costs than traditional competitors and Lean enterprises now has several parameters to compete on such as: Lowering prices, add features to products and use profit to innovate new products etc. Once set, the target cost is used to inspect the steps in the value stream (Womack & Jones, 2003).

2.2.2 The Value Stream

The next step in Lean thinking is the value stream. It consists of the actions required to guide a specific product or service through the three critical management tasks that every organisations must go through: the problem-solving task, the information management task and the physical transformation task. The problem-solving task consists of the entire product design and engineering to the point, where the product is sent to production. The information management task is the process from, accepting orders to delivering the product or service. The physical transformation task is the task of turning raw materials into finished products in the possession of the customer (Womack & Jones, 2003)

The purpose of Lean thinking in the value stream is to, identify each product throughout the entire value stream and to make sure that each step is important for the creation of a product and thereby focusing on reducing waste by removing or changing non-value adding activities. This process is also called Lean enterprises since it entails a sort of alliance and transparency between organisations both upstream and downstream in the supply chain (Womack & Jones, 2003)

The value stream is identified, by mapping all processes: From design, to order and to making a specific product. These activities are divided into three categories: those that create perceived value by the customer, those that do not create value but are necessary, at the time and cannot be eliminated yet – type-one waste, and those that can be
eliminated immediately because they do not create perceived value by the costumer – type-two waste. Once type-two waste has been eliminated the path for flow (see Section 2.1.3), pull (see section 2.1.4) and perfection (see Section 2.1.5) is cleared.

A type-two waste could be the early stages of the creation of cola cans, which is at first regarded as a type-one waste, from the mining of bauxite, which will be created into alumina and shipped across the world, by making costumers recycle more. In a perfect world with 100% recycling, the process of mining and transporting the finalised alumina could be eliminated from the value stream: reducing costs, throughput time and inventory by placing recycle centres next to the hot roller, which originally rolled the transported alumina. This creation of value has proven to be waste reducing by almost 300 days in this example (Womack & Jones, 2003) This works well in theory, but is of course not obtainable in reality since 100% recycling is impossible to reach. It does however illustrate how type-one waste can be turned into type-two waste and then be eliminated from the value stream.

The creation of cans and shipment of these is not the only concern, when implementing Lean thinking. Research and development, inventory and reordering are also very important. Having large inventory and long reordering periods is very costly (Womack & Jones, 2003). By controlling inventory and reordering periods, the service level will increase for e.g. retail stores that sell the products of producers, since they will receive products faster. This also helps inventory being reduced and reduces stock-outs, which is optimising the time constraint of costs (Womack & Jones, 2003). This JIT strategy often consists of activities that are outsourced by the producer to organisations along their supply chain, both upstream and downstream and the Lean enterprise is therefore very important in optimising the value stream (Womack & Jones, 2003)

It is important to stop thinking about activities and machines, and instead focusing on particular actions required to make particular products. Having implemented this way of thinking the next step is to challenge these actions to determine whether they create or reduce costumer perceived value (Womack & Jones, 2003).

Having created value, mapped and enhanced the value stream, the next step in the five principles of Lean Thinking is flow.
2.2.3 Flow

Having thoroughly identified value and fully mapped the value stream for the particular product while making sure that waste has been eliminated throughout these first two principles the next step is to create flow. Flow is the process of ensuring that activities run smoothly and effectively through the value chain: from raw materials to the final product in hands of the costumers while making sure that activities do not sit idle. The continuous flow is best achieved by developing product teams instead of batches (Womack & Jones, 2003).

Try to imagine going to the doctor. First, you have to call to make an appointment, then you have to go and wait in the waiting room before seeing the doctor who then tries to give you a diagnose. After you are diagnosed you often either have to go to the pharmacy to pick up your medicine or go to a specialist, where you once again have to make an appointment and wait in line in the waiting room. Your diagnose might even be so serious that you have to go to the hospital, with even more processes and functions and longer waiting times. The amount of time you spent on actual treatment is only a small fraction of the time spent on the process of going to the doctor. There is a lot of waste in this process since the only value is being diagnosed and treated (Womack & Jones, 2003).

Flow is especially important, when it comes to public healthcare services, because the costumer is part of the production process, in contrast to the traditional manufacturing process, where consumption happens in the end of the process (Womack & Jones, 2003).

Implementing flow is not easy. First, it requires focusing on the concrete object throughout the value stream, without missing one step of the process. Next it is important to ignore traditional constraints of: jobs, careers, functions and organisations to develop a Lean enterprise, with overview of the continuous flow of the particular products or services. Lastly, organisations have to reconsider processes and tools to eliminate counter flows. This way every process can proceed continuously through the Lean enterprise (Womack & Jones, 2003).

The solution to integrate continuous flow is to form devoted product teams, where members possess different skills that cover all the important aspects, of leading a particular product from the design process to reach the end costumer. This Quality Function Deployment (QFD) allows standardised work, where teams follow the same
approach every time, making it possible to detect and improve all processes related to particular products in an organisation. This also secures transparency in specifying value and reducing developing time, and most importantly it enables an organisation to do things right the first time (Womack & Jones, 2003). Regarding order-taking it is possible to merge different departments in an organisation to create more flow – this could be a merger of a Sales- and Scheduling department, in order to process orders faster and reduce waste in the form of time - also called takt time (see Section 2.1.4).

Looking at the production, Lean enterprise products and services are flowing through the concepts of JIT and level scheduling. JIT focuses on manufacturing products or services exactly when these are needed. Level scheduling focuses on shifts in demand, to make sure that there are no disruptions in the manufacturing process. Lean enterprises also seek to gather: the production manager, the buyer, the manufacturing engineer and the production scheduler, in a joined team close to the production assets in order to eliminate the gap between production and managers. To achieve this communication it is important to achieve continuous flow in the production (Womack & Jones, 2003). The traditional view of production is to, ensure that all machines are fully utilised and that every employee is kept busy, while Lean Thinking aims to ensure that machines are manufacturing the right products and that employees are not performing unnecessary tasks. Machines and employees must be cross-skilled in the sense that they are able to perform tasks exactly, when needed and that they are able to monitor their work to avoid that defects slip through the product process. It is important to know and understand the whole operation (Womack & Jones, 2003). Flow must eliminate all stoppages in the production process, and when dealing with complex products larger machinery must be broken down into smaller machinery, in order to reduce inventory waste and to get a more transparent overview of the production (Womack & Jones, 2003).

The last flow technique worth emphasising is, the location of design and production. It is important that these entities are geographically located, where it makes sense regarding serving the costumer. Traditionally these have been located far away from each other with production placed in low wage countries far away from the design department and the organisations costumers. By locating production close to the costumers transportation costs, large inventories and waiting times in shipment can be reduced and thereby create more flow in the value stream. It has been proven that this will actually be cheaper than producing in low wage countries, if costs are carefully analysed (Womack & Jones, 2003).
Continuous flow will best be achieved by managing: The value stream, eliminating potential barriers within the organisation so that all Lean techniques can be applied and result in a Lean enterprise (Womack & Jones, 2003). Employees must be able to see the whole production process, which is done by eliminating batch production and make workers more flexible, which allows them to enter different stages of the production process (Womack & Jones, 2003).

Flow can be introduced to any activity within an organisation, but it is still important that an organisation does not only focus on making production faster. It is also important that they are creating the right products and services, and that the whole value stream is tied together. This leads to the next step in the five principles, which is pull (Womack & Jones, 2003).

2.2.4 Pull

Flow is closely related to the principle of pull, which is the process of letting customers pull the products from the organisation, whenever they want, instead of pushing the product onto the customers. By creating value, mapping the value stream and making sure that products flow through the value chain, an organisation have reduces lead times drastically, which lets the organisations postpone production until the costumer demands it. This promotes the pull effect, since the customers know that they can get: Exactly what they want, when they want it, instead of being drawn by discount sales due to high inventory stocks of products that the customers do not want (Womack & Jones, 2003).

A great tool for allowing pull to be integrated in an organisation is to calculate takt times. This allows an organisation to track the rate of production to the rate of sales to customers. Takt time calculates demand and allows an organisation to produce what the customer requests, when they want it instead of producing batches that result in large inventories and waiting times (Womack & Jones, 2003). To calculate takt time an organisation needs to use level scheduling to determine allowable changeover times to meet demand (Womack & Jones, 2003).

The Lean enterprise is also of great importance, when applying the pull effect. Upstream activities must also know exactly, what to provide to the production when needed for the pull effect to be successful in the production process. If parts are not delivered exactly when needed, an activity in the process will sit idle, until these parts are delivered and the entire flow will break down (Womack & Jones, 2003). Downstream
activities also need to have an implemented Lean strategy. These organisations in the value chain will need to know, when and which products to pull to satisfy the end costumer. This could be done by changing from a weekly- or monthly ordering period, to a daily period with order quantities equal to demand (Womack & Jones, 2003). In theory this works well, but various organisations need to have some products in inventory to assist the costumers right away. Therefore the pull effect is often following the principle of, producing one product when shipping one to secure that at least one product is in inventory (Womack & Jones, 2003). These small inventories are type-one waste. They are not creating any value for the costumer, but they are temporarily needed to make activities flow. In the distant future technologies might result in that these small inventories can be turned into type-two waste, and be eliminated from the production process (Womack & Jones, 2003).

The last important change from the traditional business view is to implement visual control. Visual control allows an organisation to obtain transparency in each part of different processes and visualises disruptions in the production process. It is implemented by eliminating team leaders and instead making e.g. boards where each employee are able to monitor, whether activities or employees are producing waste. Each activity is closely monitored by the employees performing the tasks, and then checked off on the bulletin board once completed (Womack & Jones, 2003).

These changes in the production process allows an organisation to offer the highest quality at the lowest costs, and thereby eliminate the need for promotions to sell piling up inventories at low prices, and always provide costumers with the best products at the best prices. At the same time an organisation can quickly adapt to high fluctuations of demand, since flow is optimised throughout the whole supply chain in form of the Lean enterprise (Womack & Jones, 2003).

Having implemented these techniques, lead times and inventory have been reduced drastically, which allows an organisation to produce exactly what the costumer requests, when they want it and, at the same time quality has been increased, since no defects gets through the value stream, when flow is implemented (Womack & Jones, 2003). The last principle is continuous improvement also known as perfection.
2.2.5 Perfection

Perfection is at least as important as its predecessors and is, what needs to be done after all the prior principles in Lean Thinking have been obtained. Perfection is to optimise the first four principles, which with time exposes more waste that needs to be reduced. Value can be identified more precisely as the organisations learn more about their pulling costumers, which will help flow to be more efficient and happen faster in the value stream. This is continuous improvement, which is also called Kaizen (Womack & Jones, 2003). Perfection needs to be transparent to have a functional implemented Lean strategy. All actors in the value chain from suppliers to costumers and from management to employees need to know, what to do to be most efficient in order to execute Lean perfectly (Womack & Jones, 2003).

Continuous improvement can be realised by following an incremental path and a radical path. By following the incremental path an organisation is improving its processes and activities step-by-step and realise improvements over time. By following the radical path an organisation is making big changes fast, which will require instant revolutionary changes within both the production organisation, and the other members along the value chain in order to create a Lean enterprise (Womack & Jones, 2003). In reality a mixture of these two approaches is needed to chase perfection. It does not make sense to spend capital and time on improving type-one waste, which is the incremental path, that in the near future can be turned into type-two waste, which is the radical path, and be eliminated from the value stream. Following both paths require two steps: First, it is important to apply the first four principles in the Lean enterprise and secondly an organisation must decide, what waste to deal with first (Womack & Jones, 2003).

Perfection is a vision that is applied differently in every organisation across the world, and it continues in infinity (Womack & Jones, 2003). It is all about making progress, and requires effort from everyone in the Lean enterprise, and should leave the ones involved inspired and equipped with the right tools to pursue it. Being constrained by the technology at hand, a clear direction of how to manufacture products with greater flexibility in smaller volumes in a continuous flow is key. Timetables must be applied to achieve what seems like unmanageable tasks, then turned into routines and later into two-type waste.
Some organisations fail in making progress simply because they are thinking too big. To incorporate perfection accurate, an organisation needs to form a vision and choose two or three of the most important steps, to achieve goals and follow these one at a time, and later the more unimportant steps. This is a technique called policy deployment, where top managers decide upon goals that will help the transition into Lean. Furthermore, this policy deployment will assign people and resources needed for achieving goals and determine improvement targets that need to be achieved at a specific point in time. This is often done by construction a Lean policy deployment matrix, which makes the transition transparent to everyone in the organisation. It is important to notice here that the first goal-setting step is top-down and that the latter steps are both top-down and bottom-up (Womack & Jones, 2003). Once goals have been set it is important to communicate with the project teams, to determine the amount of resources and time needed to make these steps successful. Once the transition has begun, and is moving closer to the goal it will often be the situation that employees want to get more involved, and want to make new projects in order to reach the goal. Here it is once again important to keep focus on doing one thing at a time and only focus on a few projects with the available resources and time (Womack & Jones, 2003).

Having learned how and why to implement the five principles of Lean Thinking, one last and very important thing needs to be mentioned. The last ingredient moving from a batch-and-queue outlook of the world is usually to add a change agent. A change agent is an outsider, who challenges the traditional rules and inspire the employees in an organisation to follow a Lean strategy. The agent makes sure that everyone follows the same vision, and is often a tyrant. The agent will guide everyone in the organisation towards a common goal of implementing Lean Thinking (Womack & Jones, 2003).
3. What is Lean Healthcare

The manufacturing – and healthcare sector are significant different from each other. The manufacturing sector produces tangible products, which is consumed by the end customer, whereas the healthcare sector provides a service, which is consumed immediately (Wickramasinghe et al., 2014). The principles of Lean do not directly translate from Lean manufacturing developed by Womack and Jones (2003) into Lean healthcare. The five principles are still the same, but with some deviation in how the five principles are interpreted (Wickramasinghe et al., 2014).

3.1 The Five Principles of Lean Healthcare

3.1.1 Value.

The first step of Lean healthcare is, as in Lean manufacturing developed by Womack and Jones (2003), value. It is important to clearly define the customers, and what they perceive as value. It can be difficult to precisely specify what creates value for the patients in the healthcare sector. Value is not simply created by listening to the patient, because there is unequal information between the doctors and patients. Value can also be created adverse from the patient listening to the doctor (Wickramasinghe et al., 2014). It is important that the patient carefully follows the doctor’s instructions in the treatment process. If the patient does not follow the doctor’s instructions treatment might fail. The information flow is critical in the healthcare sector for the patient to get the best possible treatment (Wickramasinghe et al., 2014). The information flow is important, because patient treatment might go back and forth through different departments of the organisation, and be more complex than the processes originally faced by the manufactures at Toyota (Wickramasinghe et al., 2014). The hospitals have to think about their service as being a complementary product of the next treatment process. This means that the whole patient flow has to be taken into account (Wickramasinghe et al., 2014).

A patient might for instance announce arrival at the hospital to receive treatment. Upon arrival a nurse attends the patient and directs the patient to the X-ray department. The patient needs surgical treatment, which has a waiting list and further treatment is delayed. The point in this example is that the X-ray- and Surgical department cannot work alone, and the patient will experience dissatisfaction, due to that these departments are not collaborating as in a Lean enterprise (Wickramasinghe et al., 2014).
The value perceived by the patients is not that different from Lean manufacturing. In the healthcare sector value adding activities could be (Wickramasinghe et al., 2014):

- The quality of the treatment
- Quick patient flow with continuous information
- Short waiting lists between treatments and the overall process
- Skilled and caring treatment from employees

Value in the healthcare sector is most different in determining the target cost. In the manufacturing settings the target cost determine, whether or not a producer is able to meet the target cost, and thereby produce products (Womack & Jones, 2003). Healthcare organisations do not have a tangible product to which they can target their cost.

Healthcare organisations are often limited by a cost constraint. They can develop new services or product lines at a price that will maximise volume (Wolper, 2004). Using the right technique healthcare organisations can develop a production plan to provide their service at a specified target cost with a budget constraint (Wolper, 2004). A healthcare organisation without any constraints on budget or capacity will not be able to calculate their target cost. This means that the target cost in the healthcare sector is calculated on the actions performed in the process, and not the actual patient. Calculating target cost on basis of each patient is very difficult, because patient treatment can be a very complex process, and because patients might react differently to the treatment they receive (Wickramasinghe et al., 2014). Another aspect that is different in the healthcare sector is the way target cost is used. In the manufacturing sector target cost can be used to benchmark against competitors (Womack & Jones, 2003). The public Danish healthcare sector does not have any competitors.

3.1.2 The Value Stream.

Similar to the manufacturing sector, mapping for activities can also be applied to the healthcare sector. According to Womack and Jones (2003) the purpose of this principle is to reduce waste, but what might seem as waste in the manufacturing sector, might not be waste in the healthcare sector. Because the healthcare sector is based on information flow and not process flow there is inevitable going to be some differences (Wickramasinghe et al., 2014). This implies that what Lean manufacturing originally sees as type-two waste is type-one waste in the healthcare sector. The best example of
this is monitoring, which is type-two waste in the manufacturing sector and type-one waste in the healthcare sector (Wickramasinghe et al., 2014).

Research and development, inventory and reordering also play a central role in Lean healthcare. Research and development of new machinery and pharmaceutical is very important to give better and more precise patient diagnoses (Wickramasinghe et al., 2014). In Lean manufacturing, reducing inventory is crucial (Womack & Jones, 2003), which is not the case in Lean healthcare (Wickramasinghe et al., 2014). In the healthcare sector inventory is: shelving of materials and records, procurement of material and devices (Wickramasinghe et al., 2014). It should however be noted that stock-outs in the healthcare sector can be more serious than stock-outs in the manufacturing sector, because stock-outs of pharmaceuticals can in worst-case scenario end in fatalities (Wickramasinghe et al., 2014).

Having mapped the activities in the value stream the next principle is flow.

3.1.3 Flow

Flow is particular important in Lean healthcare. Patients with very complex illnesses might need to go through several treatment processes. It is therefore important that there exist continuous flow and that idle time is reduced as much as possible (Womack & Jones, 2003). If there is a lot of idle time between the processes a patient have to go through, it might cause implications and in worst-case scenario fatalities (Wickramasinghe et al., 2014). To make sure that there is a continuous flow at the hospitals, bottlenecks should be eliminated, which is especially important according to Womack and Jones (2003). There are several ways to deal with bottlenecks. These are among others (Wickramasinghe et al., 2014):

- Decrease the time it takes to prepare a patient
- Shift portions of treatment to other resources with available capacity or where capacity could be added easily
- Modify treatment procedures to reveal hidden capacity
- Reduce the idle time of constrained resources
- Operating rooms and other similar nonhuman resources do not need to take lunch breaks and can be scheduled to remain in use during such times
- A transporter does not abandon the post before a porter replacement arrives
A more tangible way of reducing bottlenecks is to use the 5S model which consists of: sort, set in order, shine, standardise and sustain that is also applicable in Lean healthcare (Wickramasinghe et al., 2014). The model is used to form structure. Ideally the 5S model should create a structure and standards that enables any given employee to sit down at a desk and instantly find the materials and records they need (Bak-Bernth & Vinterberg, 2010).

Implementing flow in Lean healthcare is not easy. Womack and Jones (2003) argue that, in order to make flow continuous, cross-skilled performance is required. In the healthcare sector cross-skilled performance is harder to obtain, because employees at hospitals mostly consist of doctors with long specialised education. The healthcare sector relies heavily on having high skilled labour opposite to the manufacturing sector, where it can be of lesser importance (Wickramasinghe et al., 2014). A nurse will not be able to perform a surgeon’s job because there is unequal information between the two of them. A surgeon might on the other hand be able to perform a nurse's job, implying that cross-skilled performance is limited. The amount of specialisation needed in the healthcare sector also makes it difficult to visualise the whole process a patient goes through, which Womack and Jones (2003) argue is a critical point in the flow process. Visualisation can be limited by the fact that patients are transferred between different hospitals across the country. Visualisation is however supported by journals, which allows the doctors to comprehend all the different phases the patient has been going through (Wickramasinghe, 2014).

The last flow technique used by Womack and Jones (2003) is design and production. According to Womack and Jones (2003), it is important that the production is closely geographical located to the costumer. The new “Supersygehuse” is strategically placed to cover at least 200,000 inhabitants (Ritzau, 2014), which support the statement by Womack and Jones (2003). This area is of particular importance for various reasons. Firstly, the healthcare sector cannot be outsourced. Secondly, departments who deal with patients that need critical treatment cannot be outsourced, because delay of treatment might cause fatalities.

Despite the differences, Lean in the healthcare- and manufacturing sector is obtained in the same manner, namely be eliminating bottlenecks and removing barriers. Barriers differ in the two sectors. In the healthcare sector barriers are needed in order to create a safe environment. Surgical rooms are airtight rooms that eliminate airborne contaminations (Wickramasinghe et al., 2014). In the manufacturing sector, opening and
closing doors will be seen as a barrier, which needs to be removed. In the healthcare sector it is logical to have the scrub table near the door, because it increases movability around the table (Wickramasinghe et al., 2014). In the manufacturing sector it would be counterintuitive not to have the tools at the station where it is needed (Womack & Jones, 2003).

Despite the differences in what is perceived as waste, the principles developed by Womack and Jones (2003) share some similarities with the healthcare sector. Flow suits the purpose of making production faster, hereby meaning patient throughput time (Wickramasinghe et al., 2014).

3.1.4 Pull

Pull is the principle that is most difficult to attach to Lean healthcare (Bak-Bernth & Vinterberg, 2010). In the manufacturing sector it is the product that is pulled through the organisation. In the healthcare sector it is the patient treatment that is pulled through the organisation (Wickramasinghe et al., 2014). The flow and the pull principle are closely related in both the healthcare- and manufacturing sector. One of the issues faced is the demand prediction in the healthcare sector. Wickramasinghe et al. (2014) do however argue that the demand of the national healthcare sector is highly predictable.

Pulling treatments through the processes in the healthcare sector can be difficult. The difficulties arise in the complexity of the treatment needed (Wickramasinghe et al., 2014). It becomes much more difficult to pull treatments, when the patient does not follow a linear treatment process. A patient might have to go back and forth between departments because of implications. Another difficulty is also to determine the actual timeframe a patient needs to get healthy (Wickramasinghe et al., 2014). The cycle time in the manufacturing sector tend to be precise and can be forecasted, while this is much more difficult to do in the healthcare sector prior to the service (Wickramasinghe et al., 2014).

3.1.5 Perfection

The last principle is perfection. This is just as important in the healthcare sector as in the manufacturing sector. Perfection can only be obtained by following the four previous principles successfully (Womack & Jones, 2003). To obtain perfection in Lean healthcare, it is important to deal with problems as soon as they arise (Wickramasinghe
et al., 2014). This implies that the culture has to change, so people are not afraid of telling about their failures, because latent failures will require more resources if they are kept hidden (Bak-Bernth & Vinterberg, 2010). In the healthcare sector it is of particular importance that failures are dealt with the moment they arise, because it can have severe consequences for the patients if failures are being hidden (Wickramasinghe et al., 2014).

Kaizen is also applicable in the healthcare sector. A way of sustaining continuous improvement is by implementing Kaizen-meetings. It is important that the participants at the meetings consist of workers at the operational level. To aim for perfection scorecards can be made. In the healthcare sector it is important that the goals are not set on the base of hunches but facts (Wickramasinghe et al., 2014).

In general the perfection principle is not very different from the manufacturing- to the healthcare sector. Obtaining perfection is a common goal for every organisation (Womack & Jones, 2003).
4. Lean at HH and OUH

The introduction of Lean to the healthcare sector in Denmark started back in 2011 in all of Region Hovedstadens hospitals, after having implemented the strategy in smaller departments from 2004 across the country with good results (Mølsted, 2011).

These sections seek to analyse what have been done at HH and OUH in implementing Lean healthcare in their respective organisations.

Figure 3 illustrates how Lean healthcare was implemented at OUH (top) and HH (bottom). At HH different sub-departments were assigned to implement Lean healthcare, while at OUH Lean Healthcare was introduced to whole departments and at the same time in their respective sub-departments (Bak-Bernth & Vinterberg, 2010).

**Figure 3 Implementation strategies at HH and OUH**

![Diagram of implementation strategies at HH and OUH](source: Bak-Bernth & Vinterberg (2010)).

According to Womack and Jones (2003), Lean can only be successful when implemented in the entire organisation. This statement is mostly supportive of the implementation of Lean at OUH, where entire departments implemented Lean healthcare. At HH some bottlenecks might not be made transparent as only sub-departments are implementing Lean. The key here is to include the importance of the Lean enterprise. If not all processes in the entire organisation are streamlined the patient might be exposed to a bottleneck before reaching the next department.
4.1 Value

To determine what is perceived as value in the healthcare sector, it is important to define the customer. A hospital has many different customers they have to respond to, hereby: Patients, legalisations, government, different departments within the hospital and society (Wickramasinghe et al., 2014). What is perceived, as value will naturally differ from each stakeholder. In any sector, improving performance and accountability depends on having shared goals in the organisation, and the healthcare sector is no exception. Because the healthcare sector has different stakeholders to respond to, who have different goals, determining the common goal of an organisation can be difficult (Wickramasinghe et al., 2014). Every year the government determines the financial law, thus putting a budget constraint on the hospitals (Vangkilde, 2014). This might conflict with the hospitals goal of minimised waiting time and high quality treatment.

4.1.1 Patients

One of the hospitals main stakeholders is the patient. The aim for the hospitals is to give the patient the best possible treatment, in order for the patient to get healthy as quickly as possible. Even though there might be some conflicting goals, it is in the best interest of all stakeholders that patients get the best and fastest possible treatment (Wickramasinghe et al., 2014). If values improve: Patients, regions, government and other departments at the hospital all benefit while the economical sustainability of the healthcare increase (Porter, 2010). Every Danish citizen is a potential patient, no matter the contribution they bring to the society.

In the healthcare sector value is dependent on results, and not input, implying that outcome is measured in patients healthiness (Porter, 2010). Normally value is defined as benefits of expenditure divided by the costs of expenditure. In the Danish healthcare sector this is not the case, because the service that a hospital provides has no direct costs imposed. The costs are instead indirectly paid through taxes and patients want the best possible treatment thus neglecting the cost perspective (Wickramasinghe et al., 2014). From the patients perspective value is: High quality outcome, safety of processes and delivery, and service associated with the delivery process (Porter & Teisberg, 2006). Wickramasinghe et al. (2014) recognises the same values as Porter and Teisberg (2006). According to Wickramasinghe et al. (2014) in order to create value, all aspects of Lean should be patient centred. This leads to high quality - and safe treatment. The treatment
should also be timely, meaning that waiting time is reduced as much as possible, and the actual treatment should be efficient (Wickramasinghe et al., 2014). Womack and Jones (2003) and Liker and Meier (2006) have not made a definition of, what value is in the healthcare sector, but state that all non-value adding activities should be eliminated, in order for the patients to get the best possible treatment. Since both Wickramasinghe et al. (2014) and Porter and Teisberg (2006), follows the initial strategy developed by Womack and Jones (2003), it is natural that the goal of Lean is to reduce waste, regardless of the industry.

What Wickramasinghe et al. (2014) recognised with their research on cost-benefit follows what HH recognised in their value perception. The aim at HH was, that their patients would be willing to pay for their treatment, if the healthcare service was not free of charge in Denmark (Bak-Bernth & Vinterberg, 2010). HH also has the same value perception as what Porter and Teisberg (2006) initially recognised. The same value perception is also what OUH recognised during their implementation of Lean (Odense Universitetshospital, 2007).

Viewing the hospital as one entity to determine patient satisfaction can however be difficult. The difficulty with the healthcare sector is that, every process is revealed to the patient, because the service provided is consumed instantaneously, unlike the manufacturing sector, where it is only the product or service that is pulled through the processes (Wickramasinghe et al., 2014). If waste is present in one of these processes it will reduce the patients perception of value. In the healthcare sector all processes are observable for the patient (Wickramasinghe et al., 2014). The organisation structure of the healthcare sector can make it hard to deliver and measure the actual value created by the hospital (Porter, 2010). The healthcare sector tends to measure only what they control themselves and what is easily measureable, instead of the outcome actually achieved (Porter, 2010). Thus measuring value on the basis of the whole hospital is too broad to be relevant for the patient (Porter, 2010).

Imagine a hospital with only two departments: A medical department and a neurological department. The medical department has managed to reduce their waiting time by four weeks, while the neurological department has not managed to reduce their waiting time. The hospital measures overall reduction of waiting time, which is two weeks. This measure of increased value, in the sense of reduced waiting time, is too broad to be relevant for the patient, because the neurological department have not managed to reduce their waiting time, and therefore no value have been added to patients in this
department. Value can also be measured on a too narrow scale to be relevant for the patient (Porter, 2010). An example of this could be: The X-ray department have managed to reduce their waiting time by two weeks. The next process for the patient is to be treated at the surgical department. The surgical treatment can earliest begin six weeks after initial contact with the patient. The surgical department has not been able to reduce their waiting time, and the patients will experience delays. Measuring success of the X-ray department is not relevant to the patients, because actual patient flow has not increased, and therefore no value has been created in this department, as illustrated in figure 4.

**Figure 4 Example of Patient Flow**

<table>
<thead>
<tr>
<th>Before lean</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
<th>Week 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry to hospital</td>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray department</td>
<td>Treatment</td>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical department</td>
<td></td>
<td>Treatment</td>
<td></td>
<td></td>
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</tbody>
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<table>
<thead>
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<th>After lean</th>
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<td>Entry to hospital</td>
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<tr>
<td>X-ray department</td>
<td>Treatment</td>
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<tr>
<td>Surgical department</td>
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<td>Treatment</td>
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</tbody>
</table>

Source: Own composition

An important assumption here is that patients right to treatment are based upon initial contact with the hospital. If the next process is based upon previous treatment, a reduction of waiting time in the X-ray department of two weeks will equal a total reduction in waiting times of two weeks.

### 4.1.2 Value Across Departments

One of the problems that the healthcare sector faces is the way that the service is consumed. As stated earlier, consumption of a product or service happens at the end of the process flow. In the healthcare sector consumption of service happens simultaneously with production of the service. This implies that the different sections or departments are costumers to each other.

The value that the departments aim for should therefore be aligned with the processes that the patient goes through. The example has already been explained in Section 4.1.1. Having effectively implemented Lean in the X-ray department will have no effect on the overall patient value perception, if the next department that the patient encounters has
a bottleneck. The implementation of the Lean strategy can be deployed in two different ways. At OUH they have chosen the more ambitious plan to introduce Lean in every sub-departments of the department, whereas at HH they have chosen to introduce Lean in only some sub-departments of the department. The two methods of implementing Lean have its advantages and disadvantages, which will be covered in Section 4.3.

4.1.3 Sub-conclusion

One of the hospitals main stakeholders is the patient, According to Porter and Teisberg (2006) value in the healthcare sector is: High quality outcome, safety of processes and delivery, and service associated with the delivery process. The value that both HH – and OUH recognise is similar to what Porter and Teisberg (2006) found in their research. The measurement of value is however very important in the healthcare sector, in order to be relevant for the patients. Value should therefore be measured on the basis of patient flow, and not just in departments or the hospital as one entity. If the hospitals fail to recognise this fact, measurement of productivity might be wrong, because not every patient have experienced decreased waiting times. Every patient is important in Lean healthcare, therefore Lean has not been successfully implemented if quality improvement only affects some patients.

Table 1

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quality in treatment, safety of processes, delivery processes, reduced waiting time and efficient treatment</td>
<td>1. Quality in treatment, safety of processes, delivery processes, reduced waiting time and efficient treatment</td>
<td>1. Value is eliminating all non-value adding activities</td>
<td>1. Value is eliminating all non-value adding activities</td>
<td>1. Quality in treatment, safety of processes, delivery processes, reduced waiting time and efficient treatment</td>
<td></td>
</tr>
</tbody>
</table>

Source: Own composition
4.2 The Value Stream

Mapping the value stream is important to get a transparent overview of, which activities are type-one- and type-two waste. The outcome should be a common understanding of the entire process through the eyes of the employees, which enables them to better design the future process. Furthermore, it also makes bottlenecks transparent, which need to be removed from the value stream (Womack & Jones, 2003).

As stated earlier the value stream is quite different in Lean healthcare compared to Lean manufacturing. Another different aspect is the quality. Once again, quality is the issue of the final product in Lean manufacturing, while in Lean healthcare the issue of quality is the information that flows through the processes (Wickramasinghe et al., 2014). This affects the process mapping in a way that the first step to do in Lean healthcare is, to determine the way information is passed on, and next to identify the processes that add and do not add value perceived by the costumer. The information management task is therefore of highest priority, when taking the three critical management task in Section 2.2.2 into consideration.

The analysis of the value stream at the two hospitals are divided into two sections, the first being product families and the next mapping the value stream.

4.2.1 Product Families

At HH one of the first things that was done, was to categorise different type of treatments in product families with the most similar treatments placed in the same category (Bak-Bernth & Vinterberg, 2010). The partition of these treatment processes into product families helped standardisation of work processes and promoted cross-skilled teams, so that patients could be assigned to the right treatment the first time. When dealing with treatment of patients these tasks are much more difficult, comparing it to Lean manufacturing since treatments are more diverse and harder to standardise than the production of a tangible product (Wickramasinghe et al., 2014). At HH two approaches were used. First, the easiest treatments were divided into product families, and next the more complicated treatments were dealt with. At first glance it might seem hard to divide these into product families since tasks and the patient care is very different, but by looking at the different steps in the different treatments it becomes transparent that most patients go through roughly the same treatments (Bak-Bernth & Vinterberg, 2010). Figure 5 illustrates an example from HH, where two product families
have been determined in the Occupational Therapy department, by looking at treatments with similar characteristics. The outcome at the department was to form two product families: One with five steps and one with four steps, where the differences of the two were that the first treatment involved further equipment. The figure consists of: Treatments, patients per week, treatment throughput time, numbers of therapists and boxes of steps throughout the treatment processes. By looking at the treatments “Specialiserede (i forløb)” and “Projekter” it is possible to see that these go through the same steps in the treatment process. The red circle indicates that these are now identified as a product family. The next product family consists of “Opfølgning” and “Instruktion (akutte) which have similar steps in the treatment process. There are however some differences in this product family, but most characteristics are the same. Some special treatments like “Gigt” could not be grouped into a product family, since these treatments were more seldom and therefore harder to standardise (Bak-Bernth & Vinterberg, 2010). The number of product families determines the number of value streams that need to be streamlined.

**Figure 5 Product families at HH**

<table>
<thead>
<tr>
<th></th>
<th>Anatal ptt. pr. uge</th>
<th>Beh. tid min.</th>
<th>Antal terapeuter</th>
<th>Planlagt</th>
<th>Books</th>
<th>GOIP</th>
<th>Skinne</th>
<th>Maskine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialiserede (i forløb)</td>
<td>150</td>
<td>40-60</td>
<td>1-2</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Projekter</td>
<td>2-3</td>
<td>60-90</td>
<td>1-2</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Opfølgning</td>
<td>14</td>
<td>20-30</td>
<td>1</td>
<td>x</td>
<td>x</td>
<td>(x)</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Instruktion (akutte)</td>
<td>40</td>
<td>20-30</td>
<td>1</td>
<td>(x)</td>
<td>(x)</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gigt</td>
<td>1</td>
<td>120</td>
<td>2</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indlægge</td>
<td>1</td>
<td>30-40</td>
<td>3</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

Source: Bak-Bernth & Vinterberg (2010).

One Lean project at HH divided tasks into a product family that helped the organisation assign patients to a specific doctor – either a surgeon or a medical doctor. By collecting a sample of 100 patients, it was made transparent that 70 of these were mutual patients that could be either treated by the surgeon or the medical doctor, and yield the same results. This helped HH redesign the work process of appointing patients to doctors, and thereby the treatment process becomes more flexible, making it possible to have the surgeon focus on surgery and the medical doctor focus on diagnosing the patients (Bak-
Bernth & Vinterberg, 2010). This is of course a small sample, where the results might decrease in the long run, so it is important that the department continue to observe these treatments to change the work process, if the relation proves to disappear.

At OUH product families was mapped by: The employees, the project responsible and a Lean consultant at the different departments to reveal waste that could be reduced (Odense Universitetshospital, 2007). This way of mapping the value stream is called Gemba. Gemba is a Japanese word that means actual place and the technique seeks to map the value stream at the department, where the process is actually taking place, by employees involved in the processes (http://www.valuestreamguru.com/?p=345 2015). This makes mapping of the value stream more valid, and makes sure that every aspect of the process is mapped before starting to streamline the value stream. Mapping of the value stream can also happen at the management level, but this is not recommended since the lack of experience at the operational level is more reluctant to create biases and risks that all steps in the process is not mapped (Womack & Jones, 2003).

According to Womack and Jones (2003), dividing products into product families is an important step of policy deployment, since it enables an organisation to focus on only a few goals, instead of trying to implement Lean in a lot of different directions, which will not be successful due to scarce resources and a lack of transparency. The idea is to make the most important issues transparent and focus on achieving goals set on these issues (Womack & Jones, 2013). Having dealt with these an organisation can then focus on smaller issues, which in this case is the more seldom and special treatments. However Liker and Meier (2006) emphasises that even small issues is important to deal with, because they might turn into bigger issues in the future. According to Liker and Meier (2006) it is not suitable to develop a value stream map before having divided products into product families. In Lean healthcare this is also the case. First, an organisation must identify either: A product, product family or service before identifying the value adding and non-value adding activities (Wickramasinghe et al., 2014).

4.2.2 Mapping the Value Stream

At HH a few of the personnel from a specific department were gathered, to map the value stream. The first thing they did was to map the existing process, from the beginning to the end. Cards were created with different colours for different activities e.g. red for waiting time and green for the activity in the process. These cards were then
attached to a bulletin board, which made it easy to relocate the different cards in order to make it transparent how to create the more optimal process. The next step was to identify bottlenecks and waste in the existing process, which lead to mapping the future and better process with the minimum waste and bottlenecks. The last step was to let the remaining personnel comment on the results to maximise the utility even further, and to prioritise what waste to reduce first and which constraints needed to be considered (Bak-Bernth & Vinterberg, 2010).

**Figure 6 Value Stream Mapping at HH**

Figure 6 shows an example of how, value stream mapping process evolved into the future- and better process at HH. The process illustrates how samples were treated from receiving the samples to unboxing and the registration of them in the Sample Reception department, with the original process at the top, and the future process at the bottom. The different colours and boxes represents as follow:

Green: The activity within the entire process from the delivery of the samples until another department collects them.

Light blue: The amount of employees needed for the given activity.

Dark blue: Registration of samples. Is not used in this example.
Yellow: Time and data needed for the given activity.
Orange: Observation points. Is not used for this example.
Pink: Commentaries and information. Is not used for this example.
Red: Waiting time before, between and after activities.

Mapping of this particular value stream made it transparent that it took a lot of time to unbox the samples – up to 1 hour - and that the following activity of the registration of the samples required help from other staff groups, and was at the same time also very time consuming. The original process had a lead-time of between 240 to 390 minutes and the entire process, where waiting times were excluded took between 210 to 270 minutes. The department realised that these two different activities of unboxing and registration was a batch-like situation that could be combined into only one activity, creating a situation called single-piece flow (see Section 4.3.1). This enabled the department to reduce type-two waste of waiting time, both before unboxing and between the original activities. Furthermore, the type-two waste of the requirement of help from other staff groups could be eliminated. The entire process could be streamlined by doing activities continuously instead of doing one activity before the next. The result was a new value stream, where the lead-time was reduced to between 7 and 67 minutes, and the entire process reduced to only 7 minutes.

At OUH another tool to help the efficiency of the value stream mapping was to introduce replacement boards, which had the priority of making problems transparent, and to show what went wrong in a given treatment. At the same time, these boards kept track of the improvement in e.g. changeover times at the surgical ward, which is important according to Liker and Meier (2006). At this department the results were reduced waiting times from 38 minutes to 23 minutes, which also promoted value since the employees now could find time to talk and help the patients visit the toilet (Odense Universitetshospital, 2007). OUH also implemented value stream mapping similar to HH in e.g. the retreatment department for Purchasing and Logistics with workshops, where employees from the respective departments participated. These workshops mapped the history for the departments from 2006 to 2013, to make it transparent, which changes have been done to the processes in these years. Afterwards value stream mapping was carried out in the retreatment processes to reveal waste. Waste was then divided into three categories: Physical relations, work environment and procedures. Furthermore, time spent on activities was mapped in order to make it transparent, which activities were most time consuming to determine, which activities needed to have the highest priority. The outcome of this value stream mapping was a better labour distribution,
which enabled the departments to increase satisfaction in the physical work environment from 5.8 to 6.9 out of ten, and to increase satisfaction in the mental environment from 4.8 to 6.8 out of ten (Odense Universitetshospital, 2014a). Other departments at OUH that used this way of value stream mapping include the Radiological department (Odense Universitetshospital, 2014b), Department T (Odense Universitetshospital, 2014c) and other.

At OUH the value stream mapping was not solely done by the above method. At the Hearing Care department e.g. the key issue was that the assistants spent a lot of time booking and rebooking patients, with a lack of transparency of available personnel. A planning board and a planning board team were implemented, which enabled the department to get a better overview of, which personnel were available when. Furthermore, a mutual agreement of fixed weeks for vacation making it possible to have a more sustainable work population present at all times (Odense Universitetshospital, 2011). The result was greater transparency, when dealing with sickness of the personnel, less time spent on planning and a faster reallocation of workers when needed.

According to Womack and Jones (2003) there are three critical management tasks to go through when mapping the value stream (See Section 2.2.2). These steps are not easy to transfer to Lean healthcare, since they are concerning a physical product from raw materials to a finalised product in contrast to Lean healthcare, which is based on information flow. The value stream is mapped to reveal value adding and non-value adding activities, which enable the organisation to change the value stream to only consist of value adding activities (Liker & Meier, 2006). Liker and Meier (2006) emphasises the importance of a current state map, in order to create a future effective value stream. This is what has been done at both HH and OUH, where the current value stream of specific product families were mapped, to make it transparent, which activities were not value adding and could be removed from the process. In Lean healthcare the process of mapping the value stream is the same as in Lean manufacturing and this supports that it has been done correctly at both HH and OUH (Wickramasinghe et al., 2014). The literature does not state, whether some activities at HH and OUH are type-one waste, which are needed contemporary and can be removed in the future. Mapping the value stream by the use of cards or post-it's is not the only way that OUH dealt with the value stream. Planning boards were also introduced when dealing with employee schedules instead of patients, which are also sufficient as long as the purpose is to reduce waste, and as long as the results create value perceived by the
patients (Wickramasinghe et al., 2014). The result from the Hearing Care department must be assumed to be value based, since the transparency enabled the assistants to assign patients to doctors quicker in case of sickness among the personnel.

4.2.3 Sub-conclusion

When mapping the value stream the first thing that was done at both HH and OUH was to divide treatments into product families, which is supported by both Womack and Jones (2003), Liker and Meier (2006) and Wickramasinghe et al. (2014). These product families were treatments with similar characteristics. More seldom treatments cannot be divided into product families, and should be dealt with last.

Implementation of the value stream mapping enabled both HH and OUH to streamline their determined product families, in order to reduce waste and non-value adding activities. The implementation was done as suggested by: Womack and Jones (2003), Liker and Meier (2006) and Wickramasinghe et al. (2014), but the literature does not state that there is type-one waste in the respective value streams.

Table 2

<table>
<thead>
<tr>
<th>The Value Stream</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HH</strong></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>1. Treatments are divided into product families and these are then mapped to determine the future value stream. 2. Introduced replacement boards 3. Introduced planning boards</td>
</tr>
</tbody>
</table>

Source: own composition
4.3 Flow

The next part of the analysis is flow. Flow will be divided into two different sections, HH and OUH. HH and OUH have chosen two different approaches of implementing flow.

4.3.1 Flow at HH

Creating flow is an essential part of integrating Lean successfully in every organisation and Lean healthcare is no exception. AT HH they have chosen to implement Lean in those departments with the largest bottlenecks (Bak-Bernth & Vinterberg, 2010). This means, at described in Section 4, that Lean is implemented in sub-departments. The flow strategy that HH is using is single-piece flow, which according to Womack and Jones (2003) and Liker and Meier (2006) is the ideal flow strategy. This means that a patient should receive full treatment before the next consultation. Choosing single-piece flow this implementation strategy can reveal new latent bottlenecks, which might show up, as other bottlenecks are removed (Bak-Bernth & Vinterberg, 2010). This might mean that actual waste reduction has not happened, since the new bottleneck in the patient flow creates waiting time.

Another problem that HH might face is the need for timing between the different activities. Unless the timing between the two doctors in the patient flow is right, one doctor might have to wait for the other, which essential is waste (Liker & Meier, 2006). Coordination is important in the healthcare sector, because patient flow is often complex (Wickramasinghe et al., 2014). Using single-piece flow works well for producing high volume or low-variety products or producing stocks (Liker & Meier, 2006). Since the healthcare sector is part of the service sector, producing in volume is not an option. Patients are not products, but a service, which is consumed instantly; therefore hospitals cannot produce service in volumes. Furthermore, patients are complex, and respond differently to treatments, which means that the service cannot be considered to have low variety (Wickramasinghe et al., 2014). The last point is that inventory cannot be obtained because of the instantaneously consumption of the service. An advocacy of single-piece flow is the cycle time of the patients. Single-piece flow may not be the most efficient method for short cycle-time operations (Liker & Meier, 2006). Attempting to implement single-piece flow when the tasks have very short cycle times create a high ratio of waste added to the service. According to Liker and Meier (2006), motions in the best-case scenario take half a second to perform, meaning
a short cycle time of five seconds will have one second of inevitable waste, meaning that 20% of the whole operation time is waste (Liker & Meier, 2006). The more operations with short cycle times the more non-value adding activities the patient will experience (Liker & Meier, 2006). According to Wickramasinghe et al. (2014) single piece flow is also a powerful tool that can be applied in the healthcare sector. Single-piece flow is an effective way of achieving safer patient flow, because mistakes in the treatment is made transparent immediately, which means they can be deal with it before further implications appear (Wickramasinghe et al., 2014). To achieve single-piece flow HH has tried to standardise some of their tasks, to utilise as much cross-skilled labour as possible. To do this they have implemented the 5S model.

4.3.2 The 5S Model

To ensure consistent capabilities HH has tried to create stability and standardise their work processes. To do this they have adapted the 5S model. In the first S (sort), they have made a quarantine box, of which items not used in the daily work is placed. Items can only be placed in the quarantine box for a certain amount of time before being thrown out. The second S (set in order), is making sure that most frequently used documents and equipment are easy accessible. It should also be clearly defined, where these items belong. The third S (shine) is making sure that every clinical room is always clean, so no time is wasted cleaning them right before a patient treatment is needed. The fourth S (standardise) is making sure: That what can be standardised is standardised. The last S (sustain) is making sure that all previous steps are met, by assigning a responsible staff member for every 5S model throughout the hospital (Bak-Bernth & Vinterberg, 2010).

While it is a good idea to use the 5S model it does have some limitations. One of the limitations that the 5S model might have is that it may not have an actual effect on the throughput time of the patients, if the patient's throughput is limited by constraints on equipment or doctors. Imagine having a queue of 20 people in front of the last patient entering the hospital. Consultancy with a doctor has a waiting time of two days. 10 people have already had consultancy with a doctor and are waiting to get a MR scan. The MR scanner can only treat 5 people a day, which means remaining waiting time of two days for the last person in the queue, who has already received consultancy. Using the 5S model in the consultancy department will therefore have no effect on actual patient flow, because it will just allocate the queue from before consultancy to before treatment.
in the MR scanner. This example is however a very static view of patient treatment. As discussed earlier (Section 4.1.1), patient treatment is often not static: It is often more complex and dynamic. If not all patients need treatment in the MR scanner to get healthy, but only need consultancy, it will have a positive effect on patient flow. Another issue HH might face is the limited doctors available. The 5S model seeks to standardise work (Liker & Meier, 2006). There are many tasks at hospitals that cannot be standardised, so other employees can fulfil their undertakings (Section 4.1.1). This means that only simple tasks can be standardised and not complex tasks. However standardising simple tasks can improve overall quality. Having standardised simple tasks will help new employees in the given department to easier adapt to the daily routine (Bak-Bernth & Vinterberg, 2010).

4.3.3 Spaghetti Diagram – In-cycle Losses

To reduce the in-cycle losses at HH they have used spaghetti diagrams. This is a very simple procedure, where movement of the staff was tracked before Lean healthcare was implemented (Liker & Meier, 2006). This showed that the staff had a lot of unnecessary movements. The purpose of the spaghetti diagram was to assign specific routes to specific tasks. A good spaghetti diagram will ensure that there will be no physical bottlenecks at the hospital. A well-structured spaghetti diagram will also reveal impracticalities in the hospital layout (Bak-Bernth & Vinterberg, 2010).

Figure 7 Spaghetti Diagram at HH

![Spaghetti Diagram at HH](image)

Source: Bak-Bernth and Vinterberg (2010)

The left side of figure 7 illustrates how movements were tracked before implementing Lean healthcare. The right side of figure 7 illustrates a more transparent view of these
movement patterns, where the thickness of the lines determines the frequency of the routes.

As with the 5S model the spaghetti diagram is a very easy tool to use. Getting a layout of movement can decrease the time spent between: Patient movement, fetching equipment and journals, which essentially is waste reduction. Furthermore, the spaghetti diagram can be used to relocate rooms to reduce transportation (Bak-Bernth & Vinterberg, 2010). In the manufacturing sector it is estimated that the set-up time can be reduced by 85% with an efficient spaghetti diagram (Six Sigma Material, 2015). Whether or not this can be applied directly to the healthcare setting can be discussed. Because architects and not the doctors and nurses design the hospitals, the actual layout of the hospital might not be as efficient as it could be (QIMacros, 2015). This can put some constraints on the effectiveness of spaghetti diagrams in the healthcare sector: Nevertheless a good spaghetti diagram can reduce set-up time by 80-90% (QIMacros, 2015).

Inevitability there will be some type-one waste at the hospitals, which cannot be eliminated. A type-one waste might be opening and closing of doors. This will be seen as type-two waste in the manufacturing setting, and should be eliminated (Womack & Jones, 2003). In the healthcare sector closing and opening doors might be very important for safety reasons (Wickramasinghe et al., 2014). This could for instance be to reduce the risk on contamination in the surgical room. Sterilising of equipment is another type-one waste. Sterilising of equipment happens in a separate room, where it would be more efficient to have the sterilising machine where the equipment is actually used (Liker & Meier, 2006). It is not viable to have a sterilising machine at each department where the equipment is used, because sterilising is a complicated matter, meaning that the equipment is first cleaned, disinfected and then sterilised. Then it has to be put in new packaging and be placed in stock (Regioner, 2014).

4.3.4 The SMED Model – Out-of-cycle Losses

When trying to reduce in-cycle losses with a spaghetti diagram, it is natural to look at the out-of-cycle losses. This has HH done with the SMED model also called the Single Minute Exchange of Dies model (Liker & Meier, 2006). According to Womack and Jones (2003) and Liker and Meier (2006) this is a significant tool to reduce set-up time of equipment. Furthermore, this tool can be applied to the healthcare sector (Wickramasinghe et al., 2014). The SMED model is being used at HH to reduce the changeover time of patients. They have also tried to reduce the internal and external
changeover time of doctors. The internal changeover time is, where the doctor is not working, and the external changeover time is, where the doctor is working (Bak-Berntth & Vinterberg, 2010). One of the bottlenecks that HH faces is the limited capacity of doctors that can do microscopy (Bak-Berntth & Vinterberg, 2010).

**Figure 8 The SMED Model at HH**

![SMED Model Diagram]

Source: Bak-Berntth and Vinterberg (2010).

By looking at figure 8, the left side illustrates HH before they adapted the SMED model, where they had two nurses and one doctor each assigned to two rooms. Furthermore, they had a spare room that sometimes was used to prepare the patient. At the right side of figure 8 the effects after the implementation of the SMED model is illustrated. Here they assigned teams, where each team had one nurse and one doctor. Each room had a room nurse who was only assigned to the room. The spare room was now shared by both teams, and utilised better. The result of this was, that the department was able to increase microscopy by 60% (Bak-Berntth & Vinterberg, 2010).

**4.3.5 The Result of Flow**

The way that HH has chosen to implement Lean healthcare can create some problems with measurement. As earlier established there can be some difficulties with measurement of actual effectiveness of Lean in the healthcare sector (Section 4.1.1). To measure on the basis of only one department might be too narrow to be relevant for the patient (Porter, 2010). To measure on the basis of the whole hospital might be too broad to be relevant for the patient as well (Porter, 2010). This is a problem for HH, because they cannot make a compromise of both alternatives, because not every department at
the hospital has Lean healthcare implemented, which can create ambiguity of the actual results of Lean healthcare. HH has however managed to reduce patient flow by creating value stream maps as seen in Section 4.2. This has proven that the patient flow has been reduced, since microscopy has been able to perform more treatments. It might however conflict with the fact that patient flow is not static but instead often dynamic and complex (Wickramasinghe et al., 2014).

4.3.6 Sub-conclusion

What HH has done is to recognise, where they have the biggest bottlenecks, and then eliminate them. Furthermore, Lean healthcare has not been implemented throughout the whole organisation, but only in parts of the organisations. According to Womack and Jones (2003) only implementing Lean in part of the organisation can have some implications. HH has chosen a single-piece flow strategy, which gives some implications, because of patient complexity.

The way that HH has chosen to implement flow is through the 5S model, spaghetti diagrams and the SMED model. The 5S model was used to standardise those tasks that could be standardised. After successfully having implemented the 5S model the next step was to reduce in-cycle– and out-of-cycle losses. To reduce in-cycle losses a spaghetti diagram was developed. The purpose of the spaghetti diagram was to reduce the transportation time of patients, which is waste (Wickramasinghe et al., 2014). A problem with the spaghetti diagram at hospitals is that the layout of the hospital cannot always be changed to reduce waste. For instance sterilising of equipment has to be done at a central away from the hospital (Regioner, 2014). The SMED model was used to reduce out-of-cycle losses. The model seeks to reduce changeover time, by assigning teams consisting of a doctor and a nurse, and by having a nurse assigned to a specific room, which would always make sure that the room was ready for the next patient.

Accordingly HH has designed their flow to the strategy of: Womack and Jones (2003), Liker and Meier (2006) and Wickramasinghe et al. (2014) successfully.

4.3.7 Flow at OUH

OUH has chosen to implement Lean healthcare in whole departments rather than in just sub-departments as at HH, which is more effective according to Womack and Jones (2003). As well as at HH, OUH has also adapted to single-piece flow (Thor, 2015), see
appendix 1. OUH started their implementation of Lean healthcare after HH, but has the strategy implemented in more departments than HH (Odense Universitetshospital, 2007). This implies that there are higher chances of having a patient flow, which only flows through departments, which already have Lean healthcare implemented. It also means that OUH will have an easier time dealing with the complexity of single-piece flow. Because OUH have chosen to implement Lean healthcare in whole departments, they are sure that all type-two waste has been reduced. This implies that new bottlenecks will be dealt with instead of forgotten as old are removed (Womack & Jones, 2003).

This gives OUH the advantage that the patient is actually going to notice that: Quality has improved or waiting time has been reduced in that particular department. It will also be easier to coordinate between sub-departments or departments, which might be a problem at HH, because not every department have implemented Lean healthcare. Having implemented Lean healthcare in whole departments mean that every employee in that specific department is working towards a common goal (Womack & Jones, 2003). However according to Liker and Meier (2006) having a common goal is not vital for Lean to be successful, since they may conflict with personal goals of the employee. OUH will however face the same issues as HH in regards to: complexity of the treatment (Wickramasinghe et al., 2014), the volume and variety of the treatment, and the fact that inventory cannot be stocked, since consumption happens instantly (Liker & Meier, 2006). To achieve single-piece flow OUH has chosen to use the 5S model and the SMED model in Department O.

4.3.8 Department O

A department where OUH has managed to successfully implement Lean healthcare is Department O – Orthopaedic surgery, by using some of the same tools as HH. One of the actions taken is improved transparency in the processes, which is important for Lean healthcare to be successful (Womack & Jones, 2003). OUH has also increased the information flow between every employee (Odense Universitetshospital, 2007), which is significant because the healthcare sector is based on information flow (Wickramasinghe et al., 2014). OUH also states that what really made Lean healthcare effective in the particular department was, the corporation between the Lean consultant and the employees. The employees would ask questions to the Lean consultants such as: Why, how and when to make sure they fully understood the purpose of Lean (Odense Universitetshospital, 2007). It was important that every employee in the department was
a part of Lean, whether it was a small or a big part. It is important to have every employees involved in the process of Lean healthcare (Wickramasinghe et al., 2014).

OUH has as well as HH implemented the 5S model. A problem at Department 0 had were the secretary, which was chaotic (Odense Universitetshospital, 2007). This meant that there was a lot of waste. The first S (sort) was dealt with by having every employee working overtime to throw out all ambulate notes that was unnecessary. This accumulated to 1001 ambulate notes, which were thrown out (Odense Universitetshospital, 2007). The next S (straighten) was to organise work done in Department 0. What was done was to implement a bulletin board with daily work schemes. This allowed everyone to keep track of the tasks needed done for the day. Furthermore, more categories of ambulate notes were created, where as before there were only two categories: Urgent and non-urgent. The third S (shine) was making sure that every secretary in Department 0 followed the same rules, and making sure that there was no difference in the way things are done. The next S (standardise) is hard to obtain in the healthcare sector (Odense Universitetshospital, 2007).

One of the issues that HH faced was the ability to standardise work. OUH has also recognised that it is hard to standardise work in the healthcare sector due to the high specialising requirement. To circumvent this problem OUH have chosen to provide further education for their employees (Odense Universitetshospital, 2007). It was important to OUH that the education the employees received was practical based. According to Wickramasinghe et al. (2014) further educating staff is important when the culture is experiencing change, Wickramasinghe et al. (2014) refers to this as Human Resource Management. One of the goals at the department was to utilise competences of employees better, and to promote teamwork, to provide the patients with better treatment and reduced waiting time. The last S (sustain) is making sure that the employees do not fall into old habits. To ensure this they would make sure, that tasks falling behind would be the first task made the next day (Odense Universitetshospital, 2007).

In department 0, OUH has not specifically adapted the same cycles as HH. HH chose to use spaghetti diagrams to reduce in-cycle losses and the SMED model to reduce out-of-cycle losses. The explanation can be that the department did not find it necessary. OUH does not state which model they use to control their flow. They have however managed to improve their working schedule: Thus making sure that employees arrive in time. This means that they have managed to reduce type-two waste. Another aspect that
helped reducing the out-of-cycle time was team-based work, instead of work being based on individuals. HH assigned teams to specific rooms in the department. OUH has also made teamwork a more significant part of the department, which meant they have been able to reduce time wasted in preparation of rooms and utilise the rooms better (Odense Universitetshospital, 2007).

The SMED model has also been used in department O. It has however only been implemented in the night shift in department O (Odense Universitetshospital, 2007). The constraint in the night shift was the employees. OUH experienced long transaction time concerning deliveries of patients between shifts, which are waste (Odense Universitetshospital, 2007). One of the tools they have used to make the SMED model work is, the effectiveness of the 5S model, which is also applicable to the night shifts. What they implemented was a standard, of how changeover of shifts happens. Making a standard procedure has reduced the changeover time, but also made the quality of the treatments more homogeneous (Odense Universitetshospital, 2007). Homogeneity is standardisation of the work processes and will reduce waste (Liker & Meier, 2006).

One of the strategies when trying to reduce waste, according to Liker and Meier (2006) is to use the primary Lean tools. The primary Lean tools are: The 5S model, quick changeover, problem solving among others. Department O only uses these tools. The secondary Lean tools are: Data collection and storyboards (Liker & Meier, 2006). The first tool, the 5S model has directly been used to reduce waste and make a standard procedure of the working processes. The quick changeover of staff has been dealt with by implementing the SMED model. The SMED model could not have been implemented without making the processes in the department standardised. The last part, problem solving, is dealing with problems as soon as they arise. One of the problems they faced before the implementation of Lean healthcare, was that ambulate notes was piled up (Odense Universitetshospital, 2007).

The last part of problem solving, is the implications that patients might face when treated. Because OUH uses single-piece flow, problems have to be dealt with, before transferring the patient to the next process (Wickramasinghe et al., 2014). The secondary tool to reduce waste is, data collection. Data was collected at OUH to track the amount of disturbances in regards to: Unexpected phone calls, general disturbance, how long it took to create an overview and when to file documents during the shifts (Odense Universitetshospital, 2007). The last secondary tool was to make storyboards. OUH has chosen to make storyboards in the manner of bulletin boards, where unperformed tasks
would be labelled, and then ticked off when they were done (Odense Universitetshospital, 2007). This is an effective way of making sure that no one sits idle, because everyone always have an overview of which tasks need to be done (Liker & Meier, 2006).

4.3.9 The Result of Flow

The actual outcome of Lean healthcare in department O is that a patient process now takes 23 minutes, whereas before it took 38 minutes (Odense Universitetshospital, 2007). The goal of the department was to make the whole process take 20 minutes, which means they have not yet achieved their goal, but the throughput time has significantly been reduced.

4.3.10 Sub-conclusion

OUH has chosen a different approach to implement Lean healthcare than HH. Lean is being implemented in whole departments, rather than just recognising the biggest bottlenecks and only implement Lean healthcare in those departments. According to Womack and Jones (2003) implementing Lean in the whole organisation will be more effective than just in parts of the organisation. OUH has as well as HH implemented single-piece flow. There is however some signs that OUH will have an easier time fulfilling the requirement of single-piece flow, because whole departments are following the same goals, and because processes have been carefully coordinated.

The first model that OUH chose to reduce waste in department O was the 5S model, which should be the basis of other models success. The 5S model made sure that: Unnecessary ambulate notes were thrown out, important tasks were dealt with as quickly as possible and that the processes were standardised.

The SMED model would take its offspring in the work done with the 5S model. It is a model department O chose to implement in the night shifts, where employees were the constraint. The goal was to create better standards of how changeover between shifts happened, to reduce the time spent by the night shift employees to get an overview of the tasks that needed to be done. The result of this was, that the changeover time was reduced and the tasks needed done were standardised.

Looking at the different Lean literature, OUH seems to follow the strategy developed. They chose single-piece flow, which can be hard to achieve if the processes are very complicated (Liker & Meier, 2006). According to Wickramasinghe et al. (2014) patient
flow is complicated, which could imply that single-piece flow is hard to achieve. To deal with this complexity OUH has chosen to use some of the primary tools of Lean. Both Womack and Jones (2003) and Liker and Meier (2006) recognises these tools as a good way to reduce waste and make processes standardised, which makes single-piece flow easier to achieve. These tools are: The 5S model, the SMED model, problem solving, data collection and storyboards. OUH follows the initial strategy of Womack and Jones (2003), Liker and Meier (2006), but does not neglect the complications of Wickramasinghe et al. (2014).

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<tr>
<td>2. Use of primary Lean tools (5S, bulletin board, SMED, problem solving)</td>
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<td>2. Use of primary Lean tool (SMED)</td>
<td>2. Use of primary and secondary tools (5S, spaghetti diagram, SMED, quick changeover time)</td>
<td>2. Primary Lean tool (SMED)</td>
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<td>3. Importance of common goals</td>
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<td>3. Importance of common goals</td>
<td>3. Complexity of the flow</td>
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<td>5. Lean in whole organisation</td>
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<td>5. Lean in whole organisation</td>
<td>5. Further education of employees</td>
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Source: Own composition

4.4 Pull

As earlier established the concept of pull can be hard to attach to the healthcare sector. In the manufacturing sector the products is what is being pulled through the different steps in the process, whereas in the healthcare sector it is the treatment. When establishing pull it is important for the organisation to know the demand of the patient treatment (Womack & Jones, 2003). According to a study done by Wickramasinghe et al.
(2014), demand in the healthcare sector is predictable, which means the healthcare sector should be able to make pull an effective tool to reduce waste, as is done in the manufacturing sector. Wickramasinghe et al. (2014) argues that demand in the healthcare sector is predictable, and in some departments in the healthcare sector demand can even be affected by seasons (Hall, 2013).

4.4.1 Pull at HH

At HH pull is used to make sure that the next process that the patient flows through is ready, thus reducing waiting time (Bak-Bernth & Vinterberg, 2010). This means that it is the work done by the employees that is pulled, rather than what Womack and Jones (2003) suggested, where it was the products that are pulled. In order to manage pull at HH they have collected data throughout the last year of emergency patients and planned patients (Bak-Bernth & Vinterberg, 2010). HH has experienced that demand for treatments are dissimilar throughout the day. What their predictions showed was that demand for treatments were highest in the morning and decreasing during the rest of the day (Bak-Bernth & Vinterberg, 2010). Before Lean healthcare was implemented HH had shortage of workers in the morning and excess of workers the rest of the day. The simple operation was to rearrange schedules so most employees were at work in the morning (Bak-Bernth & Vinterberg, 2010).

The flow and pull concept is closely related in both the manufacturing- and healthcare sector. Pull seems to be a small focus area at HH, since the only active action taken is to make more flexible schedules to fit demand of treatments. As written in Section 4.3.4, HH has assigned teams to the microscopy department instead of nurses and doctors operating individually. Essential this is a pull system (Wickramasinghe et al., 2014). Liker and Meier (2006) also recognise the importance of pull, especially when flow is complex, as it is in the healthcare sector (Wickramasinghe et al., 2014). The matter of the fact is that many people do not believe that pull can be achieved when there exit: High variety of the service or custom production environment, which is wrong (Liker & Meier, 2006). The high variety of service needed, is the complexity of the patients. Patients do not always follow a linear treatment process. One of the issues with this can be as earlier discussed in Section 4.3.4, the timing needed between the different activities. Since Lean healthcare at HH is only implemented in sub-departments, and not in whole departments, operations might be hard to pull without experiencing difficulties. If there is not perfect balance between in-cycle times across processes there
cannot be consistent performance and the patient will experience waiting time, which is type-two waste (Liker & Meier, 2006).

4.4.2 Sub-conclusion

HH faces some issues with their pull system. The problems are related to the problems they also face in their flow processes. Not having coordinated Lean healthcare in every part of the department might cause problems. While Wickramasinghe et al. (2014) recognise that demand is predictable, and therefore should be manageable for HH to predict, Liker and Meier (2006) suggest problems with in-cycle waste. This waste could be that different processes in the patient flow are not coordinated and the performance is not consistent, and that the performance is not consistent.

4.4.3 Pull at OUH

At OUH pull is used to make sure that the next process in the patient flow is ready (Odense Universitetshospital, 2007). Again it is the work of the employees that is pulled rather than the patients. OUH has as well as HH collected data of demand and time spent on different activities. This gives them the same advantage as HH, where they are able to predict demand for treatments more precise. This will make it easier to create schedules for employees and, which tasks needs to be done when. As well as at HH, OUH has promoted more teamwork during the implementation of Lean healthcare (Odense Universitetshospital, 2013). The biggest issue that HH faces, according to Liker and Meier (2006), is the ability to create consistency in the way pull is managed. They state that pull is not impossible to obtain even with complex processes. One of the problems was coordination between the different departments. This is where OUH has an advantage over HH since Lean healthcare has been implemented in whole departments rather than in sub-departments. OUH will therefore be able to deliver more consistency in performance, and the risk of one process in the patient flow having to wait for another is reduced.

4.4.4 Sub-conclusion

It seems like it is more likeable to have a successful pull system, where Lean healthcare has been implemented in whole departments rather than in just sub-departments. These were the findings in Section 4.3, where Womack and Jones (2003) argued that Lean would be more effective if the whole organisation has implemented the strategy.
OUH was as well as HH able to predict demand for treatments. What set the two apart is that OUH is more likely to have their processes coordinated, which would give patients more consistency in the treatments, but also reduce the waiting time between processes.

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<td>1. Pull work processes</td>
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<td>1. Pull of products</td>
<td>1. Important when flow is complex</td>
<td>1. Demand is predictable</td>
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<td>2. Collected data of demand</td>
<td>2. Collected data of demand</td>
<td>2. Importance of demand forecast</td>
<td>2. Important when flow is complex</td>
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Source: Own composition

4.5 Perfection

As stated by Womack and Jones (2003) perfection is a continuous loop that deals with streamlining of the four previous principles. It is all about continuing to make progress in defining, what and how, value is perceived by the customer, keep identifying type-two waste in the value stream and reduce it, create continuous flow and pull. Perfection is different in all organisations since no organisations are similar. The approach should though leave everyone involved, inspired and wanting to continuous implement Lean in the organisation.

4.5.1 Implementing Perfection

When implementing perfection in an organisation cultural change is often a key issue. When promoting cultural change it is important that the new culture or strategy is implemented all the way through the organisation – from top to bottom (Womack & Jones, 2003). At HH the implementation of perfection is carried out at the operational level, but initiated from the strategically level (Bak-Bernth & Vinterberg, 2010). The strategic- and tactical level deals with performance goals, while the operational level is
dealing with realising these goals by the use of Kaizen meetings as illustrated in Figure 9 (Bak-Bernth & Vinterberg, 2010).

**Figure 9 Strategy Plan at HH**

![Figure 9 Strategy Plan at HH](image)

Source: Bak-Bernth and Vinterberg (2010)

At OUH the implementation of perfection is the same as at HH. The strategy is initiated at the strategic level and driven by ideas and engagement of employees at the operational level (Odense Universitetshospital and Svendborg Hospital, 2008).

**4.5.2 Kaizen Meetings**

At HH Kaizen meetings were implemented to achieve continuous improvements. These meetings were held: Every week, had a time constraint of twenty minutes and was held by a scorekeeper, who was close to the activities of the specific department (Bak-Bernth & Vinterberg, 2010). The purpose was to promote active performance management, with the presence of scorecards to visualise the performance and an improvement wheel to show improvements made (Bak-Bernth & Vinterberg, 2010). The Kaizen meetings were held in each department, where the department manager and the rest of the personnel were present (Bak-Bernth & Vinterberg, 2010). It is important that the managers are present and takes responsibility for the learning (Liker & Meier, 2006), and that the most valuable employees at the department are present at these meetings, to keep the transparency at its maximum (Womack & Jones, 2003). The structure of the meetings were so that the departments started with a follow-up on the goals set in the department, where the focus was on facts and not gut feelings (Liker & Meier, 2006) by looking at the scorecards (Bak-Bernth & Vinterberg, 2010). This follow-up helped identify processes that needed improvements, and led to new ideas to put into the improvement wheel by the use of post-its. Next, the improvement wheel was reviewed.
in four steps: New ideas, ideas that await implementation, ideas that are being implemented and evaluation of already implemented ideas - where proposals by the employees were treated (Bak-Bernth & Vinterberg, 2010). The outcomes of the meetings need to be a mutual understanding of the goals and processes that need to be improved (Womack & Jones, 2003). Kaizen meetings can both be held at specific departments or at multidisciplinary departments like the Pathological department at HH. Kaizen meetings were also applied in administrative departments (Bak-Bernth & Vinterberg, 2010).

At OUH the implementation of continuous improvements was the same as at HH. Weekly Kaizen meetings were implemented with the presence of Kaizen teams from specific departments, where scoreboards were processed. However, at OUH blitz-kaizen was also introduced (Odense Universitetshospital, 2007). This is a specific variant of Kaizen, which promotes quicker problem solving by cross-functional employee groups (Wickramasinghe et al., 2014).

All the literature available for OUH supports that the implementation of Kaizen meetings is, what has been done to implement perfection at the different departments. This includes Department I, Department M and other (Odense Universitetshospital, 2015). However, some departments have introduced other perfection tools as well.

4.5.3 Other Perfection Tools

Other tools that were implemented at OUH beside scorecards and Kaizen meetings were satisfaction barometers, which were implemented by the use of red and green balls at Department O (Odense Universitetshospital, 2007). These balls could be placed in two different Plexiglas tubes – one where a red ball could be placed if the patient was not satisfied and one where a green ball could be placed if the patient was satisfied. Furthermore, the patients were able to stick a post-it to one of the tubes with suggestions for improvements. According to Wickramasinghe et al. (2014) this patient centred approach is a good way of promoting value, and according to Womack and Jones (2003) also improves quality. At the end of each day, the employees held a brief meeting, where the colours and improvements provided from the daily patients were discussed (Odense Universitetshospital, 2007). This tool helped visualise issues that the specific department might not have realised, and at the same time helped the employees discuss daily frustrations, which resulted in a better work environment. Some suggestions from the patients could be placed directly on the boards used at Kaizen
meetings and results were put up on posters at the specific departments so that the
patients could follow the improvements made (Odense Universitetshospital, 2007). A key
result here is amongst other that employees get an insight into the expectations of the
patients, which promotes how value should be specified continuously.

According to Wickramasinghe et al. (2014) Kaizen follows an incremental path with
smaller improvements and here no radical path is followed. Womack and Jones (2003)
state that a mixture of an incremental- and a radical path is needed to reach perfection.
The radical path is more revolutionary and was followed once deciding to implement
Lean in the entire organisation, which was done at OUH (Odense Universitetshospital and
Svendborg Hospital, 2008).

The Kaizen meetings at both HH and OUH did not embrace the fact that only a few of the
most important goals should be pursued. Unreachable goals should be neglected, and
focus should instead be on a few reachable goals. If this were not the case at the
hospitals, then transparency and simplicity would be hard to reach. According to
Womack and Jones (2003) it is important to only follow a few goals to promote
transparency in an organisation. Having to many goals seems bewildering and focus is
removed from the actual purpose of continue to improve work processes. However
Liker and Meier (2006) emphasises that smaller goals should not be neglected, since
they eventually can evolve into bigger issues.

According to Wickramasinghe et al. (2014) in Lean healthcare it is important to deal
with problems as soon as they arise. Weekly Kaizen meetings and scorecards promote
this, as done at both HH and OUH.

Womack and Jones (2003) state that, when implementing perfection in an organisation
the way to change the outlook of an organisation is usually to add a change agent. This is
not the case at HH and OUH. Instead Lean consultants, where hired to help departments
implement Lean (Odense Universitetshospital, 2007) and (Bak-Bernth & Vinterberg,
2010). This supports the incremental path of making small implementations instead of
an entire cultural change, which is more important in manufacturing organisations
(Wickramasinghe et al., 2014).

The big question that remains, is whether weekly kaizen meetings is really enough when
implementing perfection in a healthcare organisation? This will be the focus of Section 5.
4.5.4 Sub-conclusion

At both HH and OUH the implementation of Lean healthcare is initiated at the strategic level, but carried out at the operational level. Perfection is implemented by the introduction of Kaizen meetings at both HH and OUH. Another tool implemented is a satisfactory barometer at OUH, which promoted how value should be continuously specified.

This way of implementing perfection follows an incremental path and it must be assumed that at both HH and OUH a few goals were selected and prioritised. Kaizen meetings and scorecards promote dealing with issues as soon as they arise. A change agent was not added at both organisations, but instead Lean consultants who helped with smaller incremental changes.

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<td>2. Incremental path</td>
<td>2. Incremental path</td>
<td>2. Promote transparency and mutual understanding</td>
<td>2. Based on facts not gut feelings</td>
<td>2. Patient centred</td>
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<td></td>
<td>5. Lean consultant</td>
<td>5. Add change agent</td>
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Source: Own composition
5. Securing Continuous Learning in Danish Healthcare Organisations

At HH and OUH continuous learning was implemented by deploying weekly Kaizen meetings, where issues and ideas were discussed and prioritised. According to Wickramasinghe et al. (2014) continuous improvements are based on smaller incremental changes that are entirely based on the outcomes of how value, the value stream, flow and pull are specified and dealt with. As stated in Section 4.5 this is what characterises Kaizen.

Though, over time it can be hard to keep coming up with ideas for improvements, which might result in going backwards and falling into the traditional way of working at the hospitals (Bak-Bernth & Vinterberg, 2010). It is key that this does not happen. At this phase, it is important to keep the employees inspired and satisfied, and it might be necessary to promote other continuous improvement tools or philosophies (Wickramasinghe et al., 2014).

5.1 TQM

Total Quality Management (TQM) is a philosophy that promotes continuous improvements in the long run (Wickramasinghe et al., 2014). Instead of promoting smaller incremental changes at the operational level, TQM focuses on involving all parts of the organisation in continuous learning (Wickramasinghe et al., 2014). It emphasises the importance of continuous education of the employees, while managers at the strategic- and tactical level stay involved and support the implementation of the principles of TQM throughout the organisation. This involvement by the entire organisation requires cultural changes, which is a more radical path of implementing perfection, but the main focus is still to continue to improve processes within the organisation (Wickramasinghe et al., 2014).

The tools of TQM are as in Kaizen: Scorecards, but promotes quality in a broader perspective (Wickramasinghe et al., 2014). Brainstorm techniques are introduced in order to make causes of problems transparent, and the use of matrix diagrams force employees to think of relationships between different processes and visualise these processes weakness, strength and pattern (Wickramasinghe et al., 2014). Customer needs and preferences are made transparent by the use of tree diagrams, which also promote issues and which issues to prioritise. When ensuring to successfully implement progress in processes critical path analysis is implemented (Wickramasinghe et al.,
2014). This tool establishes a chronological order of activities within the value stream, including time available and priority of a project by the use of networks of arrows and nodes. Control charts are used as a statistical tool that help managers at the strategic level control the processes (Wickramasinghe et al., 2014). Pareto analysis is a tool that supports, which activities and why these should be prioritised. It shows the 20% major causes that result in 80% of difference in the processes (Liker & Meier, 2006). Management should prioritise to focus on these 20% since they have the biggest influence on processes (Wickramasinghe et al., 2014).

Lastly: Some cost, inventory and value promoting tools such as benchmarking, JIT, Quality Lost Function and QFD is implemented in order to visualise those processes that perform the worst and best in the organisation (Wickramasinghe et al., 2014).

All of these tools ensure that the continuous improvement is directed, and enables an organisation not to fall back on their progress. Big as well as smaller changes can easily be identified and the changes prioritised are easily made transparent in a continuous loop. Furthermore, quality is promoted in a greater sense thus promoting value perceived by the customer even more than in Kaizen (Wickramasinghe et al., 2014).

Having realised how TQM can be implemented to secure continuous improvements in the long run, several other tools can be used within Kaizen to help promote continuous learning in the long run.

### 5.2 Other Kaizen Tools

When focusing on securing continuous learning in Danish healthcare organisations, some actions have been taken at these healthcare organisations: Performance scorecards, Kaizen meetings, Lean audit, Process owner, Lean education, Lean ambassadors and Lean network.

#### 5.2.1 Performance Scorecards

When holding Kaizen meetings it is extremely important that the performance scorecards are accurate and very detailed to make it transparent, whether the departments are making progress or not. Goals set at Kaizen meetings should be tangible so that the performance can be measured (Bak-Bernth & Vinterberg, 2010). Problems with scorecards are however that there are scarce resources, time and lack of
competences at the operational level to construct these scorecards properly. This can be solved by collaborating with someone who can help the departments collect these performance data and present them by the use of scorecards (Bak-Bernt & Vinterberg, 2010).

5.2.2 Lean Audit

Together with performance measurements, Lean audit is an essential part when securing continuous learning. It is a tool that helps the management and the personnel secure that implemented processes and workflows are performing as agreed upon throughout the implementation of Lean healthcare. It is a regularly measurement of performance for specific processes and workflows at specific departments. A Lean auditor can be: A Lean consultant, a project participant from the department’s Lean project, a quality coordinator or a patient responsible employee. Besides the Lean auditor, a member of the department management and a member of the local quality group at the department can be present at a Lean audit (Bak-Bernt & Vinterberg, 2010).

At these audits, the value streams are evaluated. Are the personnel executing the agreed upon changes in the value stream, and are they yielding positive results. Furthermore, an evaluation of the Kaizen meetings is carried out. Are they being held frequently as agreed upon, is the agenda followed and is a member of each department involved present. Moreover, are suggestions still being made, are these suggestions being implemented, and can these implemented suggestions be maintained in the value stream. Lastly, an evaluation of the scorecards is carried out. Are they being prepared each week, are they being used by the management and personnel each week and are the results progressive (Bak-Bernt & Vinterberg, 2010).

Lean audits involve the strategic- and tactical level with the operational level in the organisation enabling them to communicate with each other. This is a part of policy deployment that forces the management to get involved with processes at the operational level and to decide upon, which goals are most important and achievable and how to link strategy plans across departments to promote the Lean enterprise (Womack & Jones, 2003).
5.2.3 Process Owner

A process owner is an employee who is giving responsibility of a specific process. This is done when processes are too complex for the management to control the progress. The responsibility of a process owner is to make sure that a specific process is performing as agreed upon and to take action when issues become visible (Bak-Bernth & Vinterberg, 2010).

If a process is very complex and have different liability shifts it can be recommended to divide the responsibility into two process owners: main process owner and part process owner (Bak-Bernth & Vinterberg, 2010).

The main process owner is an employee in a given department that is in charge of making the process flow from start to end. This employee should have a common interest in achieving goals set by the management, and is being measured by the output produced of the department. Lastly, the main process owner needs to secure that all processes are being measured, improved and are being followed up (Bak-Bernth & Vinterberg, 2010).

The part process owner is given the responsibility of a specific sub-process, which entails coordination of, when and how the process should be conducted. It is often a team responsible or a technical coordinator, which is involved in the daily operations. Often, there is more than one part process owner who is responsible of different sub-processes in the entire process. It is very important that these can react quickly to changes in the operations (Bak-Bernth & Vinterberg, 2010).

A process is divided into sub-processes by going through the value stream. It is made clear, where part process owner’s responsibility starts and ends, and how to measure performance at each sub-process (Bak-Bernth & Vinterberg, 2010). Communication is extremely important in order to secure that the entire process flows smoothly (Wickramasinghe et al., 2014).

5.2.4 Lean Education

Lean education consists of courses that are available within an organisation, and have many advantages. It can help employees gain Lean skills and promotes interest in Lean healthcare. An incitement for participation is that employees are given a certificate once having participated in these courses (Bak-Bernth & Vinterberg, 2010).
Lean courses can consist of: A basic course in the five principles of Lean by applying cases and exercises, a Kaizen course that train employees in what Kaizen meetings consist of and how they are being held, a Lean leader course that train leaders in how to be a leader after Lean has been implemented in a department.

Experience has shown that Lean education helps inspire employees to continue to make improvements at their specific departments (Bak-Bernth & Vinterberg, 2010). Being educated in Lean is very important in the healthcare sector since the patient is part of the production process (Wickramasinghe et al., 2014).

5.2.5 Lean Ambassadors

Lean ambassadors or Lean agents are often externally hired and are in charge of implementing cultural changes. Their main functions are to strengthen the Lean initiatives and to promote the Lean Thinking in the different departments (Bak-Bernth & Vinterberg, 2010). The purpose is to make sure that a Lean identity is created within the departments (Womack & Jones, 2003).

Having a Lean ambassador or a Lean agent has several advantages. They support continuous learning and continuous improvement at the departments, which benefits both the employees and the patients. Furthermore, they recognise what have been done at the departments promoting motivation and can help solve issues as soon as they arise. Lastly, they create a network that enables employees to consult with each other regarding Lean related challenges (Womack & Jones, 2003).

The tasks of these Lean ambassadors or Lean agents include holding Kaizen meetings and it is required that they have participated in Lean education courses (Bak-Bernth & Vinterberg, 2010).

The greatest advantage of the Lean ambassadors or Lean consultants is implementing Lean in an organisation. The greatest disadvantage is however that once these have left the organisation, it is entirely up to the management to secure continuous learning (Womack & Jones, 2003). To ensure this does not happen, a staff member can be promoted to Lean coach. The Lean coach continues the work of the Lean ambassador or Lean agent and is often passionate about the strategy (Liker & Meier, 2006).
5.2.6 Lean Network

To secure future progress in the implementation of Lean healthcare a Lean network for hospitals have been created (Bak-Bernth & Vinterberg, 2010), which has the purpose to allow Lean consultants to share ideas and experiences with the implementation of Lean healthcare at Danish healthcare organisations (Bak-Bernth & Vinterberg, 2010).

By the use of these tools and philosophies, the chance of securing continuous learning is improved. The greatest importance is to keep focusing on implementing changes in the value stream, while continue to promote the Lean enterprise (Womack & Jones, 2003) and keeping everyone in the organisation inspired (Liker & Meier, 2006). In Lean healthcare the main purpose is to continuously challenge work processes to deliver healthcare most efficiently with the greatest quality (Wickramasinghe et al., 2014).
6. Can Lean be Applied to The Danish Healthcare Sector

The purpose of the Lean strategy is to keep improving. To keep improving it is necessary to lead for changes. Lean manufacturing was developed at Toyota and was a utopian environment, where everyone shared a common goal, which started with the customers (Liker & Meier, 2006). It then looks like if an organisation is to implement Lean successfully, everyone in the organisation should have the same goals (Womack & Jones, 2003). Dealing with the healthcare sector we now realise that not everyone have the same goals (Wickramasinghe et al., 2014). Departments and even individuals within the hospital might have different goals they strive towards. The differences do however not stop within the organisation. Goals might also differ from the hospitals board to the expectations of the public or through different goals from the government (Wickramasinghe et al., 2014).

Successfully implementing Lean according to what Toyota did seem very difficult in the healthcare sector. Luckily this is not the case, according to Liker and Meier (2006), the assumption that everyone should strive towards a common goal is plane wrong. Personal goals and expectations is therefore something the Danish hospitals should take into account, when trying to implement Lean. At Both HH and OUH this have been achieved by giving the employees ownership of how the processes are done. The employees are present at Kaizen meetings, where their ideas and suggestions will be taken into consideration. The importance of having employees that support Lean is stressed by Wickramasinghe et al. (2014), which state that costumers often base their impression of the firm's service. It is therefore important that the Danish healthcare organisations not only focus on patient satisfaction, but also focus on the employees that have to deliver the services. The important objective of Lean is to have people, who are passionate about the changes and have a vision. A good vision will embrace those who support it and oppose those who do not. The success of Lean will depend on how well the organisational culture supports alignment around a common goal, but does not neglect that it will meet resistance and compromises (Liker & Meier, 2006). According to Liker and Meier (2006) there are no indications that Lean cannot be applied to the healthcare sector.
6.1 The role of The Top Management

The top management is important when trying to implement Lean. One of the success criteria’s for Lean Thinking at Toyota was that the leaders had hands-on experience, of what was going on at the operational level. This was achieved by having the engineering office where the actual production was happening (Liker & Meier, 2006). This is called Genchi Genbutsu, which states that understanding can only be achieved by deeply observing what is going on (Liker & Meier, 2006).

**Figure 10 Role of Structure in the Change Process**


Figure 10 illustrates that the executive sponsor is involved in two aspect of the process. The executive sponsor provides resources for the organisation, which is not limited by a budget, and has all the sources of power to make changes (Liker & Meier, 2006). In the case of the healthcare sector the executive sponsor is the government. This can cause some problems with Lean in the healthcare sector, since there might be differences in goals from the hospitals point of view and the government’s point of view (Wickramasinghe et al., 2014). Every year the government determines the finances of the public sector. Natural this means that the executive sponsor sets a budget, which originally is against what Liker and Meier (2006) suggested. Working on a budget can however be successful in the healthcare sector. Flinders Medical Centre, a medium-sized
public hospital in Adelaide, South Australia showed that after implementing Lean they could operate below the budgeted costs (Wickramasinghe et al., 2014).

There are no reasons why the Danish healthcare sector should not be able to introduce Lean. The study from South Australia showed that a budget might be a constraint, but it should not rule out Lean completely. The other aspect is the accountability. This might be a problem, because the executive sponsor does not have all the resources available to make it happen. In 2014 the doctors in Denmark could only fulfil 93% of demand (Rasmussen, 2014). This means that the lack of doctors might affect the effective implementation of Lean in the organisation. On the other hand the lack of doctors available might stress the need for Lean even more, since it is a scarce resource and the hospitals want to utilise their expertise to its full (Wickramasinghe et al., 2014). To accommodate this problem the hospitals can try to implement some of the primary Lean tools.

This has been done at both HH and OUH. Both hospitals have applied tools that standardise work with the 5S model in cooperation with the SMED model, and allow cross-skilled abilities. Having cross-skilled employees is important in the manufacturing sector (Womack & Jones, 2003) and (Liker & Meier, 2006). In the healthcare sector is it also extremely important to have as much cross-skilled labour as possible (Wickramasinghe et al., 2014). This cross-skilled labour could be attained through teams that are involved in the patient treatment. This has also been a successful way of implementing Lean at both HH and OUH. This allows the hospitals to utilise their scarce resources fully. The teams should support processes in the patient treatment, where there might be potential bottlenecks. It is however not unnatural to encounter difficulties when trying to adapt an organisation to Lean (Liker & Meier, 2006).

The process owner is also an important element, when trying to figure out, whether or not Lean should be applied to the organisation (Liker & Meier, 2006). The process owner has to be held accountable towards the executive sponsor. It can be discussed if the hospital is actual a process owner, or it is an executive sponsor. One of the problems that might arise with this is that the sponsor must truly understand the status of the improvements (Liker & Meier, 2006). This means that the executive sponsor must have Genchi Genbutsu, which is not the case. The Minister of Health and Prevention, who represents the government, does not have an office at each hospital to monitor improvements. The executive sponsor should spend time weekly with the owner coaching, challenging thinking and thoroughness, and providing the needed support.
(Liker & Meier, 2006). In the case of the hospital board with the Minister of Health and Prevention this might not happen. Creating relationships within the hospital is much easier however. At both OUH and HH the process owner is represented at the department, which has implemented Lean. Both hospitals have Lean consultants or a Sensei attached. This means that there is a close cooperation between the executive sponsor and the process owner in the daily work, which is important (Liker & Meier, 2006).

A recent initiative from the government was the implementation of “Slusetelefon” at the hospitals. The purpose of this was, that the patient would call the hospital before seeking consultancy. This meant that the hospitals would be able to consult some patients over the telephone, which meant they did not need treatment at the hospital. This was supposed to save time spend on treatments at the hospitals. At OUH they have not experienced any positive effect of this new initiative, and they want to abandon this project, because it is costly and did not create any value perceived by the patients (News, TV2, 2015). Such a new initiative might affect the performance of Lean negatively, because it is not aligned with the Lean strategy that the hospital has chosen. This is a good example where the executive sponsor does not have Genchi Genbutsu.

As established earlier, Lean is implemented differently throughout different hospitals across the country. Having a common strategy plan for all hospitals will then not work, because different organisations require different initiatives (Liker & Meier, 2006). Furthermore, the hospital cannot simple get rid of the initiative. First they have to consult their results with Regioner, which then decides whether or not the hospital is allowed to drop the initiative (News, TV2, 2015). Making the hospital the executive sponsor will ease the implementation of Lean, and all internal new initiatives will be easier to either skip or keep.

6.2 Middle Manager

At both OUH and HH there is an in-house Lean consultant. Liker and Meier (2006) state that the middle manager is an important part of the organisation to make Lean work. The middle managers job is to make sure that ideas turn into actions and results. The middle manager at most departments at the hospitals is a doctor. The head doctor of the department posses the greatest threat for the Lean consultant, when trying to implement Lean (Liker & Meier, 2006). A small fraction of the managers will quickly accept the ideas of Lean, but a great mass of the middle managers will stay undecided.
for a while (Womack & Jones, 2003). There will also be managers who never go along with the ideas of Lean. These managers should be removed of command, because they will only highlight mistakes and can jeopardise the results of Lean. Even though the executive sponsor posses the final power of the decisions, the middle manager has the power to get things done.

In earlier sections there was some problems with the link between the executive sponsor and the process owner. Lean is not impossible to implement without the support from the executive sponsor, it does however make it easier with the support (Liker & Meier, 2006). External energy from outside Lean consultants or Sensei’s are important to keep driving, teaching and pushing towards perfection (Liker & Meier, 2006). As Lean becomes a more integrated part of the organisation, learning should be internal and come from the Lean responsible at the department (Liker & Meier, 2006). This of course means that Lean can be implemented successfully in the Danish healthcare sector. This is because the processes that have to do with the operational level are more important than the processes dealing with the strategic- and tactical level (Liker & Meier, 2006).

6.3 The Operational Level

According to Womack and Jones (2003) every level of the organisation are important for Lean to be successful. Liker and Meier (2006) also recognises the fact that the operational level is important for Lean to be successful. When trying to change the culture towards a Lean culture it is important to identify sociometric stars in the organisation (Liker & Meier, 2006). Liker and Meier (2006) see an organisation as a network, where every employee is connected through communication ties, social ties or emotional ties. When leading for cultural changes it is important to get the approval from the sociometric stars, because their opinion matters more than other employees, because they have a large network within the organisation, and can cause a lot of resistance if they oppose the new strategy. The Lean consultant should seek out these employees and formally involve them in the change process from non-Lean organisation to a Lean organisation. A good way of including these key members at the organisation is through Kaizen meetings, or even to make them responsible of small groups of Kaizan meetings (Liker & Meier, 2006). Successfully implementing Lean will require that the workforce understands the root of the cause. Asking the workforce to implement Lean techniques will likely follow a rush of suggestions and usually make them disillusioned, when these techniques fail (Womack & Jones, 2003). It is therefore important that the
Lean consultant and the middle manager are able to explain the root of the cause, and educate the employees to deal with the problems that might arise.

Taking every above aspect into consideration, Lean healthcare is suitable for Danish healthcare organisations. As stated by Womack and Jones (2003) and Liker and Meier (2006) every tier of the organisation is part of the Lean implementation at both HH and OUH. Implementing Lean healthcare in Danish healthcare organisations will though face some difficulties, which is not unnatural according to Liker and Meier (2006). The biggest issue is the executive sponsor, which is the government that does not have *Genchi Genbutsu*. The most important part when trying to implement Lean is the process owner, because Lean can still be implemented without the support from the executive sponsor (Wickramasinghe et al., 2014).
7. Conclusion

Lean healthcare is a specific form of Lean Thinking, in the sense that healthcare organisations provide an intangible service, where manufacturing organisations provide a tangible product. Lean healthcare according to Wickramasinghe et al. (2014) is based on the five principles of Lean originally developed by Womack and Jones (2003). The value perception of the manufacturing- and healthcare sector shares many similarities, but also differences. Value in the healthcare sector can also be created adverse, where the patient listens to the doctor, where in the manufacturing sector Womack and Jones (2003) state that the organisation should provide what costumers demand.

The value stream in the healthcare sector also shares many similarities with the manufacturing sector. In Lean healthcare it is important to map processes, in order to identify waste. Waste is however defined differently in the two sectors. In Lean healthcare monitoring the patients is important, while it is seen as waste in Lean manufacturing. Differences across organisations do however not eliminate the effectiveness of Lean (Liker & Meier, 2006).

Where Lean healthcare is significant different from Lean manufacturing is in the principle of flow (Wickramasinghe et al., 2014). In Lean manufacturing the focus is on process flow, where as the focus is on information flow in Lean healthcare. Single-piece flow is the essence of Lean, whether it is in the manufacturing- or healthcare sector.

Pull is the most difficult principle of the five to apply to the healthcare sector. In Lean healthcare it is the treatment that is pulled through the processes.

The last principle is perfection, which is obtained similarly in the two sectors. Lean healthcare focuses on having a problem solving culture (Wickramasinghe et al., 2014), which is the same as in Lean manufacturing (Womack & Jones, 2003). To ensure continuous learning primary Lean tools such as Kaizen can be applied to Lean healthcare.

Lean healthcare was implemented at HH and OUH by using the five principles developed by Womack and Jones (2003). The implementation of the strategy at the two hospitals varied, where OUH implemented the strategy in whole departments, and HH only implemented the strategy in sub-departments. Value in the healthcare sector is defined as being perceived by the patients, which consist of every Danish citizen, who emphasises on: High quality, safety and service. At the same time value is reduced
waiting times and effectiveness of treatments. Value should be measured based on patient flow, instead of on the whole hospital in order to promote value perceived by the customers.

The value stream is mapped at both HH and OUH by first dividing similar treatments into product families, which promoted standardisation of work processes. However, patient treatment is much more diverse than the production of tangible products, leaving the more complicated treatments out of the product families. Mapping the value stream was carried out by: The employees, a project responsible and a Lean consultant at the different departments, and the purpose was to reveal waste that could be reduced from the value stream. First, the existing process was mapped from the beginning to the end by posting coloured cards on a bulletin board. These cards were then rearranged in order to create the more optimal process, where bottlenecks were removed and waste reduced. The value stream was also identified by the use of replacement- and planning boards.

Flow was implemented at both hospitals by using single-piece flow, which means that a patient should retrieve full treatment before the next consultation. Single-piece flow is also an effective way of achieving safer patient flow, and was implemented at HH by using the 5S model, spaghetti diagrams and the SMED model. The 5S model was used to standardise tasks, the spaghetti diagram to reduce in-cycle losses and the SMED model to reduce changeover time of patients and doctors. At OUH single-piece flow was achieved by using the 5S model, the SMED model and problem solving, where problems were dealt with as soon as the arise. Lastly, storyboards where implemented in order to make sure that no employees sit idle.

Pull is what differs most when comparing Lean healthcare and Lean manufacturing. In Lean healthcare the treatments are being pulled instead of products. At HH pull was used to make sure that the next process a patient flows through is ready, by creating more flexible work schedules. At OUH the same actions were taken to implement pull as at HH. Though OUH is more likely to succeed with their pull system since Lean healthcare is implemented in whole departments, instead of only sub-departments.

Perfection is achieved at the operational level but initiated from the strategic level, and is being implemented by weekly Kaizen meetings, where the four previous principles are discussed to keep improving. This implementation of perfection follows an incremental path where smaller improvements are continuously being applied.
Continuous learning is secured at HH and OUH by implementing weekly Kaizen meetings. However, to secure continuous learning in the long run it might be necessary to promote other continuous improvement philosophies such as TQM, which emphasises on involving all parts of the organisation in continuous learning. This might require cultural changes and the philosophy promotes quality in a broader perspective than Kaizen. The tools of TQM make continuous improvements directed and ensure that an organisation does not fall back on their progress. Other tools that help promote continuous learning in the long run is Lean audit, which links the whole organisation together, process owner, which links processes together, Lean education where employees are educated in implementing the Lean strategy, Lean ambassadors which strengthen the Lean initiatives and a Lean network created for Lean consultants to share ideas and experiences regarding the implementation of Lean healthcare in Danish healthcare organisations.

Lean healthcare should be applied in public Danish healthcare organisations the same way that Womack and Jones (2003) and Liker and Meier (2006) suggest, namely by having the support of the workforce. It is not unnatural when implementing Lean to experience difficulties, and those difficulties should not make the Danish healthcare organisations abandon Lean healthcare. When trying to implement Lean it is important that the ones in charge of the Lean project have Genchi Genbutsu. This could potential be a problem in the healthcare sector. However Lean healthcare can be successful without the support of the executive sponsor, whereas it cannot be successful without support from the workforce. The main focus is to have a clear vision, which is supported by the workforce, and that the management accepts that the workforce will have different personal goals. To lead for changes the organisation should make sure to get the approval from sociometric stars, because they potentially can threaten the implementation of the strategy. Taken this into consideration implementation of Lean healthcare is in fact very similar to Lean manufacturing, and is suitable for the public Danish healthcare sector.
List of references


Thor, C. (2015). VS: Lean bachelor om OUH. Email to, 31. March: [Claus.Thor@rsyd.dk](mailto:Claus.Thor@rsyd.dk)


Appendix

Appendix 1

Mikkel Mortansen

Til: ouhlean@ouh.regionsydjylland.dk
Leon Bachelor om OUH

Høj OUH.

Jeg er igang med at skrive en bachelor om lean-implementering i den danske sundhedssektor sammen med min studiegruppe. Vi er igang med at skrive om, hvordan i håndterede flow. Vores plan er at se om der er forskel på, hvilken flow modeller der bliver brugt på forskellige sygehuse. Vi har fundet ud af, at Nordjylland bruger single-piece flow, vi kan dog ikke finde ud af, om i øvrigt bruger dette. Er det noget i i kan gøre os klogere på?

Hilsen Mikkel og Martin

Claus Thor

31. mar. 2015 kl. 06.11

Høj Mikkel

For os er "single piece flow" en del af at arbejde med lean, da alternativet er "batch production", som automatisk vil give fiksekvalitet og uavhengig af flow i vores behandling af patienter og dermed øget verdt.

Venlig hilsen

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---Oprindelig meddelelse---
Fril: OUH Lean-steam
Sendt: 30. marts 2015 14:28
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Høj Claus

Vil du svare?

Pfr.

Venlig hilsen

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