Lean Implementation in Healthcare:
Redesign and Organizational Behavior

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Lean thinking had and is being used in the production and manufacturing plants for the increase in the efficiency and effectiveness of the job performer. This has significant impact on the output in terms of cost, quality and availability of the product on the demand. In healthcare, the lean thinking is the one of the best possible solutions could be optimized to provide safe and quality health treatment by identifying, removing all non-value adding activities in the processes flow related to patients, staff, visitors, supplies etc. The treatments with the costly equipment, new technologies and drugs as well as the ageing challenges in the developed countries makes the decisions makers think for the redesign and construction of new premises. This report first will provide the thorough study of lean thinking in the redesign and construction of new premises but also the effective organizational change in the healthcare. The seven wastes of Lean in healthcare have been identified. Secondly, a case study example was also done on New Karonliska Hospital (NKS) where Lean thinking is used in the redesign and construction of new premises but also impact and need of organizational change for effective and efficient outcome.
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Chapter 1
Introduction

Stockholm County is the Europe one of the fastest growing capital. The population of Stockholm is more than two million with the increment of about three hundred and fifty thousand by 2020. The whole country population is more than nine million expected to reach ten million by 2035 according to Statistics Sweden (SCB) (Svenskt Näringsliv, 2011). Being a best social welfare state the greatest challenge is to provide the safe health care. The Stockholm County is top in the list for the increment of population as well as life expectancy is high. As the life expectancy is high the population of children and elderly people age groups are higher compared to any other age groups. This has direct influence on the quality, effectiveness and efficiency of the healthcare.

The Stockholm County started projects in the renovation; expansion and building the new hospitals which will have direct impact on the safe and effective healthcare. They have invested almost forty two million in the improvement of the health care which is highest investment of the country compared to other cities. Big amount from the forty two million is being invested for the healthcare of children, youth and for the geriatrics. For this reason 650 new beds are being created by 2018 which will assure the right care at right time and place (SL, hälso och sjukvård). Beside all these renovation, expansion as well as building new facilities which will take years to be completed the top management of the hospitals has already taken into account the Lean philosophy. The new constructions, renovations as well as the expansions are being done with the consultations of the top management in order to minimize the motion of patients, long waiting time, inventories as well as the defects in the treatment for the safe and quality healthcare. New Karolinska Hospital (NKS) is one of the goods examples of the projects with all facilities to minimize the seven Lean waists for the safe and quality healthcare.
1.1. New Karonliska Hospital/Nya Karolinska Sjukhus (NKS):

The New Karolinska Hospital (NKS) is one of the projects of healthcare by Stockholm county council which will be completely operational in 2018. The motto of the newly construction is *Patient First*, which means that the building is not only designed but also equipped with modern equipment and division of the departments is made so that the patient have safe, effective and efficient treatment. The architecture of the hospital is made on the Lean philosophy of healthcare as the X-rays and scanning laboratories, surgical rooms and devices are designed/constructed so that the movement of the patient is reduced and to have more improved patient flow.

Beside all these NKS is equipped with the smart logistic system so no more in need of the large storage rooms as the transportation of the medicine, food and textiles will be done using the pneumatic tubes and the delivery to the wards will be done via robotics using separate elevators. The NKS will be equipped with the updated modern IT solutions such the patient treatment records which will help in the safe, effective treatment and can be obtained by concern person whenever required.

It is the state of the art hospital with all the facilities in one building and focusing on the integration of research, education as well as training. The total investment on the project is almost 14.5 billion SEK, the building is almost twelve floors with thirty eight operating theaters, one of the ideas are having 630 single rooms for admitted patients with its private wc/shower and one hundred day cares. The keys for the first section have been handed over to the Karolinska hospital by Skanska which is the contractor for the construction of the NKS. Starting with the Child, Women and the Heart healthcare departments intend to receive the patient from Nov 2016 (Nya Karolinska Solna, 2014).
1.2 Problem Statement:
The Stockholm County is fastest growing County in the Sweden and Stockholm County is responsible for the public safe healthcare as well as transportation. It is estimated that by the end of 2020 the population will reach around 350,000. There is also increase in the children and old people with the ageing problem which is good sign but on other hand is the problem of resources. Therefore big changes and investment are needed in the structural as well as management of the internal structure including the different treatment processes (Svensk Näringsliv, 2011).

Karolinska Hospital is among the largest hospitals in the county where continuous improvement is done on the daily basis. As the continuous improvement is being done on the daily basis still the hospital has problems with waiting queue, over crowded, lack of good staff and large inventories. KI hospital works together with the county council and KI for the improvement of the safe healthcare processes. This also includes the construction of new advance facilities, safe healthcare with short time and integration of the research and education which will result in the good staff.

Astrid Lindgren is children hospital which works with the Karolinska hospital. Astrid Lindgren hospital is located in the Solna, Danderyd and Huddinge. Neonatal is a department where sick newborn and premature children are treated with special care. Neonatal department is among the two which will move to the NKS first in Nov 2016. The Neonatal patients need few tests from the outside of the department for the treatment process for example X-rays which will be performed within the new facility of the NKS. There are still few issues regarding the treatment methods or processes to be improved as the department are working at three different location. The most suitable solution is the value stream mapping of the activities as well as the vertical organization structure instead of the horizontal in order to remove the Silo phenomenon, resulting in the good communication and collaboration.
The implementation of Lean thinking in the healthcare is very successful which results in the elimination of the wastes, long waiting times for treatment as well as diagnosis and large inventories. This has direct impact on the reduction of the patient movement with the result in the safe and quality healthcare. It is important to study the basis for the construction of the New Karolinska Sjukhus (NKS) and how Lean philosophy has been implemented in the whole project.

1.3. Research Questions

The aim of the thesis work is to study the challenges in the effective and efficient healthcare in the Stockholm Sweden. The long term goal is reducing the waiting time overcrowding and effective processes for patient treatment. As an example a case study is made on the Karolinska hospital as a whole and study specifically Neonatal department of the Astrid Lindgren in Solna regarding the effective, efficient and safe patient flow. Lean philosophy has been implemented as well as the organizational structure of the Neonatal department has been studied to eliminate the unnecessary wastes and waiting for the effective treatment processes.

- How Lean seven wastes are studied and implemented in the redesign and construction of the healthcare?
- What are the barriers and challenges in Implementation of Lean at the organizational level?
- What is the expected output after the successful implementation of Lean for both customer and job performer?
- The driving force for the starting of project NKS of worth 42billion?

1.4. Research Scope and limitations:

The research in the project work is limited to one hospital Karolinska located in Solna& Huddinge Stockholm. The scope of the research study is limited by the following parameters:
1.4.1 In Scope

- Study thoroughly the literature regarding the Lean implementation in Health sector.
- The significance of the Lean implementation in term of patient safety as well as treatment process effectiveness and efficiency.
- Gathering information from key personal of KI using qualitative method.
- Lean implementation in the new project NKS.
- Study the activities and the departmental structure of the Neonatal department of NKS

1.4.2 Out of Scope

- Comparing the data with the other hospitals in the county
- To study the Lean in all departments of the NKS
- To study the organizational changes in all departments of the NKS
- To study in detail all the outcome of the Lean integration in the department of the NKS

1.5 Structure of Thesis:

The rest research work is structured as follows. In Section two literature reviews will be done, focusing on the Lean in healthcare and its significant outcome as well as its impact on the organizational behavior. In section three we will go through the research methodology and the types of methods for the data collection in qualitative analysis. In the section four we will discuss the findings from the interviews, seminars and make a comparison and analysis with the literature studied. Finally, section six provides the conclusion of the overall work performed and further recommendations for future research. Research outline is as follow:
Figure 01: Thesis outline
Chapter 2
Literature Review

In this chapter we briefly explained the theory related to our study and obtained from the literature study. We started with the Lean brief introduction including the historical development its implementation and output in terms of continuous improvement. We focused on the Lean thinking adoption in the healthcare and also presented a case as an example. In the end of the section we wrote briefly about the organization hierarchy and job performer behaviors for the continuous improvement.

2.1 Introduction to Lean

After, WWII the Japanese automobile industry was almost zero and at this point they set a goal to reach the Europe and America industry with in the time frame of three years. In 1998 Taiichi Ohno first introduced the Toyota production system known as TPS for the efficient production system in Toyota manufacturing, eliminating unnecessary wastes constantly. For achieving the goal of removing the wastes the two basics were, Just-in-time (JIT) and automation. JIT purpose was to reduce the flow and response time both in the production and customer or supplier (Thomas, 1989). According to Ohno, customers are the ones who set the price which mean changing the traditional formula (Selling price= cost + profit) used by the manufacturers, to selling price – cost= profit, so focus was to reduce the costs to increase the profit. Therefore the Toyota production system focused on the eliminating the wastes which were in terms of overproduction, waiting, inventory, defects and transportation.

The Lean thinking was first introduced in 1990 by the James p. Womack et al., where they published a book the machine that changed the world: The story of Lean Production in US. In any process there are two types of activities: the activities that add value to process results in the increase in efficiency of the process and high quality. Whereas the activities that do not add value to the process results in delaying the process efficiency and
output quality are low that is unacceptable both for the customers as well as clients (Wickramasinghe et al., 2013). Lean was basically used in the manufacturing process for the increase in the efficiency and improved quality by removing or reducing the wastes, according to customers demand as well as satisfaction. The main aim was to fulfill the demands of the customers efficiently, effectively, improved and safe quality with minimum wastes. There are seven wastes given in the literature for the Lean thinking that can be eliminated or reduced for any effective and efficient output (Thomas, 1989). The seven lean wastes of Lean are shown in figure 1.

Figure 02: Shows the seven wastes of Lean & their potential Output

2.1.1. Basic Principles for Lean Implementation

The Lean thinking was first presented and explained by Womack as a basic tool for the continuous improvement in the manufacturing industry. This was introduced in US to compete the Japanese TPS used in their automobile industry. To successfully implement the Lean thinking there are five basic principles (Womack & Jones, 1996). These five principles are as follow:

- **Value:** For the successful implementation of the Lean the very first step is Value. In any process or activities in a process the ultimate
end result is gaining the customer satisfaction. Value is set by the customer and is expressed in terms of product or service fulfilling the desires of the customer. (Womack & Jones, 1996; Wickramasinghe et al., 2013)

- **Value Stream:** The second principle in the Lean implementation is the Value stream mapping. This means dividing all the activities into sub-activities from the order received to the product or service delivered to the end customer. Thus identifying the Value added (VA) and non-value added (NVA) steps. Non-value adding steps are known as wastes, most of it can be completely eliminated and some can be reduced to create a value (Womack & Jones: 1996; Hicks, 2007).

- **Flow:** Identifying and removing the wastes allows the Value adding (VA) steps in the process for a smooth flow of work to reach the target.

- **Pull:** After the flow of the process the fulfillment of the product or services must be done according to the customer demands. Which means, let the customer pull the flow.

- **Perfection:** The last principle of the lean thinking directs towards the continuous improvement. After the successful implementation of Value streaming and flow whenever there is harder pull the uncovered wastes are observed which must be removed for the achievement of the best value (Womack & Jones, 1996; Tsasis & Bruce-Barret, 2008).
2.2 Lean in Healthcare:

Lean thinking has started from the manufacturing of automobile industry and is now being successfully implemented in the logistics, hotel management (Vlachos & Bogdanovic, 2012), other services such as construction (Gao et al., 2014) and Healthcare. With the passage of time healthcare services face many challenges such as ageing populations, sensitive diseases, technology and increase in the costs. The government officials, doctors and other clinician are focusing different possible solutions such as expansions, renovations and using ICT. Experts take this as solution for few of the problems and that can be short term. Lean thinking is needed in the Healthcare unlike the manufacturing there are several wastes in the processes related to the patient treatment. The processes for the product manufacturing or the services provided in the healthcare treatment are similar in the sense that the waste of money, time and errors/defects can be reduced.

The Lean implementation in the healthcare needs identification of the customers and their values (demands as well as needs). The second step is to identify the non-value adding activities or processes (wastes) and then eliminate/reduce the wastes. In the healthcare the primary customers are its patients. The foremost needs or demands of patients are quick response (less waiting), less errors and correct medication (quality and safety). Therefore the steps or activities that are non-value adding in the patient’s values are known as wastes (Randnor et al., 2012). These activities or steps (wastes) are identified using the visual stream mapping to be removed or minimized for the excellent output. This can be achieved by the customers together with the staff involved in the activities/processes of related to the treatment. The final changes suggested and for the approval need the higher management decision. Higher management support and leadership is vital for the lean thinking
and for the continuous improvement (Tsasis et al., 2008). The successful implementation of the lean can give following output:

![Figure 03: Lean Implementation with the significant outcome from Tsasis (2008)](image)

One of the good examples of the Lean implementation in the Sweden healthcare is the St:Goran and Skåne university hospital where it was started with the mutual agreement of the Government officials and the senior clinician. In the Skåne hospital Lean philosophy has been implemented with the very good output. There are almost 12500 employees in the hospital and it (Lean) was started in the Rehabilitation department where patients with the central pain disorder are treated. First of all, the managers were the trainers or teachers of the staff to train them how to work with the lean and to improve their work flow. The work started with the overall system mapping i.e. daily routines, patient progress control reports and overtime. One of the basic problems identified by mapping the process was the lack of the daily routine guidelines.

According to the Skåne hospital, Lean can be defined as the house with roof as the main aim which is continuously improving and getting better all the time. The house has two pillars which are the Lean principles. One is about all the activities are visible and connecting for the smooth flow whereas second is the quality and safety whereas staff working have to monitor closely any change/problem or any activity goes wrong is identified and solved by doing root cause analysis. The base consists of the two important things; one is the equal workload every day and second is the agreed written standards and procedure which is helpful both for the patients and staff. In the center of the house is the
patients and job performer which is directly linked with them. The example of the Skåne Lean House is shown in the figure below:

![Skåne Lean House Diagram](image)

**Figure 04: Skåne hospital Lean house (Example)**

### 2.3 Wastes in Healthcare:

The main customer in the Healthcare is the patient and every step/activity that hinder the process of treatment, quality and safety is waste. The operational efficiency of the healthcare will increase if these seven wastes are eliminated or reduced. The seven wastes of the manufacturing industry explained by the Womack and Jones (1996) are related and explained in terms of the healthcare service (Radnor et al., 2012). These are as follows:

- **Defects:**
  The defects in the healthcare service include wrong information delivered, patient discharged wrongly causing re-admission, operations went wrong or wrong drug provided (Wickramasinghe et al., 2013).
• Transport:
  It is the transportation of the patient for necessary medical tests or examination. The movement of the patient to the CT scan or MRI before taking to the operating room it also includes the motion of the supplies and staff required.

• Motion:
  The extra movement of the medical staff to collect the medical results or information needed in the patient treatment. That is the for example X-rays or MRI results. Movement also includes the placement of the different obstacles with in the treatment or operating room.

• Waiting:
  The waiting in any process has direct impact on the output resulting in the unsatisfied customer. In the healthcare treatment waiting or delay in any process may result due to the several reasons i.e. lack of staff, prescribed medicine or medical reports for taking next action in the treatment process.

• Over processing:
  In the health care over processing can occur by the repetition of any activity. The over processing may occur by requesting patient information which is already in the system or by requesting information which is not required.

• Over-production:
  Overproduction in the healthcare service is making medical tests which are not compulsory for the treatment. This also relates to the internal management, setup and responsibilities i.e. when patient is discharged leaning his/her bed unprepared or having extra beds or other furniture in the room.
• **Inventory:**
  In healthcare it is referred to the waiting lists for the special surgery, or patients to be discharged. It also includes the patient waiting for medical reports assessment.

• **People:**
  The eighth waste in the healthcare has been explained and added as lack of the effective and efficient staff or staff with good experience. It can also be a case when hospitals have very competent staff and they have no opportunity to give their input or suggestion for the improvement (Hicks et al., 2015).

The above seven wastes of the lean can be identified, eliminated and reduced using the Lean five principles. The wastes and principles are shown in the figure below:

![Figure 05: Shows Lean five principles in identifying the seven wastes](image)
2.4 Lean and Organizational structure:
Organizational structure plays an important role in the achievement of the aim and goal of the organization. In order to satisfy customers and compete with the market any organization or business internal structure play important role. The organization structure has direct impact on the quality and productivity as well as it can differentiate the success or failure of any business. The achievement of the goal and satisfaction of the customers depend on the managers of the organization that they understand the business (Rummler et al., 2012). Any organization or business has two different organizational structures
i.e i. Vertical view
   ii. Horizontal view

i. Vertical view:
In the vertical view the instructions always comes from top to bottom. All the functions/departments in the organization work vertically. The employees in the specific department report to their managers at the top. The goals in each department or function are achieved independently. This vertical organizational work is somehow workable in the small businesses/organizations as the managers as well as employees know each other but as the business and organizations expands with the passage of time this can be a bigger problem. Each function/department start to achieve their goals separately and as a result the managers of the one department/function want to become hero compare to the other and this can end in the silos cultures. Similar Silos appears in the Hospitals when the staff at the information desks, wards, theaters and radiology works in the vertical departmental. The staff in each department is not process focused instead are more concerned about the departmental output (David, 2007). This creates delays, duplications and errors in the patient treatment as well as frustration and burden for the frontline staff.
ii. Horizontal organizational view:
In the horizontal structure of the organization all the departments are interconnected and work performed in the horizontal way. The work done is visible to job performer as well as the customers and suppliers. The work is performed in the teams and each and every member of the team has clear work/job to perform. The work output of the each department is added to the common goal of the organization. The success of the organizations is the success of the all the departments for examples if there is high value of sales then it not the success of the sales department but it is achievement of R&D and manufacturing department (Rummler et al., 2012).

The organizational structure can make the culture of the organizational receptive or resistive. In order to apply Lean thinking in any organization it is important that the culture of the organization is receptive and the higher management can play a significant role. In Lean management it is important that the leaders of the organization are committed to the thinking and rather than direct implementation (Lean thinking) it should
be introduced to the staff, members of the organization. The staff may fear the job losses and the process meant to improve the system, may cause problems for the smooth and improved output. After the assurances and importance of the lean is communicated then the staff is to be involved in the whole process of redesigning and eliminating wastes. The job performer (Staff) is the one who can identify, eliminate and reduce wastes for the continuous improvement of the process. There should be a platform where the staff voices must be heard regarding criticism as well as suggestions for the changes only then a successful implementation of Lean can be possible (Tsasis & Bruce-Barrett, 2008).

![Figure 07: Example of Horizontal organizational Hierarchy from Rummler et al. (2012)](image-url)
A research project has method and approaches on how to collect the desired data. In this chapter we will discuss the research method used for the collection of the data for our case study performed at the Karolinska Hospital. The data is further analyzed and its validity and reliability is evaluated for the master thesis project.

3.1 Research method:

The task in a research project can be achieved through a systematic procedure which includes initial, middle phase (carrying out) and ending. There are several research methods such as quantitative, qualitative and fundamental etc. The qualitative research which is also known as the non-experimental method, in this method any research phenomenon can be explored. In the qualitative method any phenomenon can be easily explained by the small reliable obtained data. The literature study was done in parallel so that enhances the knowledge related to the Lean, its implementation in the healthcare and study the few cases and examples in the healthcare.

In the said project we used the qualitative research method to study the Lean implementation in the healthcare. We have study and taken a case example of the Karolinska University Hospital under the name NKS. For the case study of the Lean implementation in NKS we prepared an open ended semi-structured interview questions. The data was collected from the key persons of the Karolinska institute who are directly involved and job performer of the activities. Then the final conclusion was explained from the empirical reality which is also known as the inductive approach in the research methodology.
3.2. Research Process Overview:

The case study was conducted on the research paradigm or framework explained by Collis and Hussey. The research can be conducted based on two approaches Positivism and Interpretivism. Positivism approach of research framework is originated from the natural sciences and in the philosophical term known as realism. This approach of case study involves a deductive approach. Whereas, interpretivism is opposite to the positivism approach and is based on the Idealism in philosophical world. Interpretivism approach is more inductive process of research or case
study. In the said project research paradigm was based on the interpretivism approach (Collis & Hussey, 2014).

The project we conducted in the Lean implementation in Swedish healthcare which includes a case study as an example of the Karonliska University Hospital project NKS (New Karonliska Hospital). The case study explains the phenomenon we would like to research on, which is more realistic. It also gives an opportunity to researcher to gather sufficient information for detail investigation and explanation of the phenomenon (Blomkvist & Hallin, 2015). There are four phases in the said project which are shown in the figure above including the literature review which was done in parallel to all the phases. The literature review includes the books, relevant published articles, brochures of the annual reports as well as the brochures of the hospital. The pre-study was done by going to the workshop and seminar organized by the KI management regarding the New Karonliska hospital (NKS). Meeting and interviewing people there was helpful to get appointment and identifying the department that can be interesting to further study in terms of Lean implementation. Besides this, literature study was also conducted to get knowledge of the Lean implementation in different services specifically in the healthcare.

In the second phase of the process, interview and data collected from the key staff and management involved in the project of the NKS. For the activities and patient process the department of Neonatal was chosen. All the results including the empirical data which we obtained were from the chief doctor of KI also responsible for Quality & patient safety, chief nurse Neonatal, quality coordinator Neonatal and the manager from the Skanska construction (involved in the NKS construction). The literature study was also conducted in the second phase to have better understanding of the healthcare and Lean while conducting interviewees.

Both the primary and secondary data obtained were used in the result section for the further analysis. The primary data was obtained from the interviews and seminars whereas the secondary data from the documents
and reports of the KI and NKS as well as the Neonatal department. The results were analyzed in context with the literature study including the annual reports from the other healthcare organizations. In the last phase of the research all the data collected and results obtained are concluded with the final suggestions and recommendations.

3.3. Data Collection:
There are several methods to collect data for the research depending on the topics. In our case where we used qualitative research method so the data collected in this method were interviews, observations, documents (reports, diagrams or figures and printed material) from the seminars/workshop visit.

3.3.1 Workshops & Seminar:
In the pre-study we had visit to the workshop for the New Karonliska institute (NKS) and we had met the several people there regarding the highly cost new project NKS. We had got very important information and understanding regarding the new technology in the NKS as well as the Quality and safety of the patient. The increase in the efficiency of the patient treatment in the NKS was also discussed. Several brochures were collected which were very helpful in the selection of the department for the further study.

Second seminar was also attended which was basically for the newly employed staff in KI. It was related to the quality and safety of the patient. The seminar had detailed information about the yearly goals and the achievement made from the previous year. Followed by the seminar show room of the NKS was also visited as open for the public in specific days and hours. The showroom has processes of different treatments with the output of less waiting time, videos and the design of actual patient room with the facilities which will be available in the NKS.
3.3.2 Interviews:
There are two types of interviews quantitative (structured) and qualitative (unstructured, semi-structured) for the data gathering. In the project we have chosen the qualitative method where we used an unstructured method of interview in the first stage of the research to get a general view of the phenomenon (Lean in healthcare) used in our case study. In an unstructured method one is not focused on the output and is beneficial to explore the desired topic. In the second stage when we gathered information and knowledge then we follow on the project with the semi-structured interviews. Semi-structured interviews are more commonly used methodology to collect the relevant data. In the interview type the most questions are prepared beforehand and flexibility is expected between the interviewer as well as informant (Blomkvist & Hallin, 2015).
The interviews were conducted with the key person at the KI. All the interviews were conducted face-to-face. The time duration was almost one hour and these were unstructured but some general questions were prepared. The interview helps us a lot in understanding efforts made in the continuous improvement of the healthcare in KI. The initial interview with the Chef Doctor and manager from the NKS helped us in choosing the department for further research. Then further appointments in Neonatal helped us in study their patient treatment process and the internal structure.

3.4 Ethics:
Swedish research council considers the ethical part an important content of any research or degree project. They have mentioned four main points which are as follow (Blomkvist & Hallin, 2015):
- The purpose of the study should be mentioned to the person being interviewed.
- Case study must be done on the approval
- The data (reports, information) gathered must be confidential and
shall be shared freely.

- All the data gathered must be used for the stated purpose.

In the qualitative research where data collection is done by the interviews, so the ethical consideration or moral principles are important to taken in account. We followed the Swedish research council ethical points in the conducted case study. The appointments were requested via email and required proof (signed transcript and ID) of being master student at KTH were sent to them. The general questions for the research were also sent to them prior to the interview so that the respondents feel confident during the meeting. The interviewees were also requested permission regarding their identity and work position if mentioned in the report. As the interviews were for the educational purpose they were preferred to be conducted face-to-face. The time given by the respondent was taken in to account during the interview and if few minutes more required the respondent’s permission was asked. The printed material provided by the respondents were also asked if can be published in the report with references in the result and analysis part.

3.5 Reliability and validity:

The reliability of any research result can be marked higher if the research is repeated with same collected data (Collis & Hussey, 2014). This can increase the credibility of the research work performed or the published results. In the project work the reliability can be low in the beginning but to increase the reliability all the interviews were conducted face-face- face and research process was developed. The important notes were written during the interview process. At the end of the each interview few extra minutes were given in the end of each interview session where they were confirmed with the respondents using the method of the triangulation which reduce the bias in data (Collis & Hussey, 2014). The data we obtained from the secondary (annual reports and brochures) sources is
highly reliable as all were provided by the respondents. The other secondary data is from the published articles and books. The second aspect of the credible research is the validity of the research. It’s the results obtained during the research are the desired ones and reflects the topic (Collis & Hussy, 2014). In the said project to achieve the higher validity semi-structured interviews were performed to have open ended questions. The interviews were performed with important persons from the top and middle management. To increase the validity interviews were prepared a side the literature study of published material. The high validity is a pre-requisite for the increased reliability whereas high reliability of any research work does not guarantee the validity of the work. Higher validity in the said project is achieved by following the four points (Blomkvist & Hallin, 2015).

- Relevant literature study
- Theory mentioned in the theory part is used for the analysis and explains the purpose
- The purpose, interview questions tally the data collected
- The end discussion is about the purpose of the research work and answers the questions.
Chapter 4
Results and Analysis

In this section we have explained our results obtained from the gathered data. The results are explained in context to the theory/literature we have mentioned, is applied to our specific case study. The information gathered in the empirical form is also analyzed to get the possible output to the challenges in the Healthcare.

Results obtained and presented in this chapter reflect how Lean can be used as a tool for the continuous improvement i.e. removal of wastes and value adding steps. We have explained the also the significance of the organizational behavior for the successful implementation of Lean. All this is in context to our example case study of New Karonliska Sjukhus (NKS).

4.1 Karonliska Hospital:

For the case study we have chosen the Karonliska university hospital which is Stockholm county council best hospital in the health care, patient safety and quality. It stands in the three pillars healthcare, research and education which makes its Europe one of the largest hospitals.

The vision of the Karonliska hospital is Patient First, which means that patient is given the best possible treatment and attention. The vision of Patient First makes the Karonliska Hospital take equal attention in the patient care together with the education, research & innovation. The Karonliska university hospital has almost:

- 1600 beds
- 15800 employees
- 1,6 million visits per year
- And annual budget of ~18 billion sek

4.2 The Organizational Pyramid:

Previous studies shows that the Hierarchical structure of an organization can have control on the stability of the processes and quality outcomes
but will fail to achieve the innovations which depends on the flexibility, growth and creativity (Bortolotti et al., 2015). It is vital for the higher management to lead the Lean besides this an overemphasis is needed on the frontline workers related practices. The significant involvement of the job performer will not help in achieving the long term goals but they will be ready to any change needed (Dickson et al., 2009). This will result an effective lean implementation i.e. reducing the inconstancy in treatment processes and long queue which will give cost reduction, process flexibility and quality work (Bortolotti et al., 2015).

In the case study of the Karonliska University hospital the decisions made by the top management whereas the information flows between the top management and the job performer are opposite to the traditional organization hierarchy model. In the traditional organization model, if taken as pyramid, the authority, final decisions for the changes as well as new implementation is always at the top of the pyramid. The information always flows down from job performer up to the top management. In KI hospital the organizational pyramid is upside down which means the job performer are the ones for the decisions and actions according to the needs of the customers where Top management gives their approval and support. Being close to the customers and keeping the vision as well as value of the customers make the internal culture of the organization flexible adopting the new changes for the patient quality, safety and continuous improvement. The inverted pyramid organization model is effective as the top management gives priority to the job performer suggestions and decisions needed for the continuous improvement. This gives freedom to the job performers to take decisions and give recommendations for the elimination of the wastes and to improve the processes by removing, identifying the nonvalue adding steps within the available resources (Bortolotti et al., 2015). The job performers are given resources and time to enhance as well as develop new skills of the team work in achieving the goals of the organization.
The top management facilitates, motivate and make sure that all resources are available. The director & division head of the Hospital is at the bottom of the organization model but is most of time find with the job performer level for motivation and being an effect leader. The figure below shows the organizational structure of the KI.

![Organizational inverted pyramid (hierarchy) of Kraronliska Hospital (KI)](image)

Figure 10: Organizational inverted pyramid (hierarchy) of Kraronliska Hospital (KI)

4.3 New Karonliska Solna:
The New Karonliska Solna (NKS) is state-of-the-art hospital which is built and designed by Skanska. The Stockholm city council is both the customer and client. The cost for the construction of the NKS is about 14.5 billion
which is highest investment in the healthcare by the Stockholm County. The aim of the highly cost project is to provide safe and quality healthcare to the patient. It is not only to provide safe and quality healthcare but also install and upgrade the treatment services. The construction, modernize design of the NKS is based on the continuous improvement in the patient safety and quality treatment as well as for the effective role of the job performers.

The design of the newly built hospital is to work according to the vision ‘Patient always first’ by the fast diagnose and treatment of the patient which is based on the Lean Philosophy focused on the reduction in the waiting times as well as removal or reduction of wastes (Tsasis et al., 2008). The new design is also to integrate the healthcare, education and research for the quality treatment but also to make a research on the new advance procedures and medicine. In hospitals the patient movement or the drugs delivery processes are the main causes for the cost and high risk for the patient safety, whereas in NKS both of these aspects are taken into consideration (Hicks et al., 2015). There are two types of variations, natural and artificial, in the processes at the operational level which can be identified and reduced. Artificial variation is the one which is controllable and variation exists in the design and management of the healthcare system (Joosten et al., 2009). Below are the findings related to the Lean thinking in the design and construction of the New Karonliska Solna (NKS):

4.3.1. Single Patient Rooms:
Healthcare design plays a vital role in the cost and healing process of patients; therefore single patient rooms are one of the recommended by the health professionals in the redesigning or newly built hospitals. Single patient rooms are of great interest in the hospitals of US, UK and specifically Netherland where 100 % single rooms are built in the new hospitals. They have significant impact on the Quality and safe healthcare of patients as well as cost (Chaudhury et al., 2005). Several studies have
been made on the impact of single patient rooms showing reduction in the risk of cross infection, patient stress, noise level, medication errors, rate of nosocomial infection, patient transfers, and length of stay. There is significant increase in the privacy, control and patient satisfaction. The shorter stay which means effective and efficient healing process and reduction in the patient transfers due to single rooms decrease the costs as labour costs decreases (Van de Glind et al., 2007).

In our case study we found that the nosocomial infections and the disease transmissions for the patient under treatment is big challenge for the Karonliska hospital which gives loss of about 640 million to the budget. The single patient rooms are best suitable solutions for controlling the problem where the patient and extra bed for the patient visitor are available. There are 630 single patient rooms where patient can have its privacy as well as the doctors and other medical staff can focus on the treatment process. According to the Lean thinking the single rooms for the patient will reduce the defects and the over processing in the treatment of the patient.

The single rooms will provide comfortable environment to the patient to have direct interaction with the medical staff whereas this will also provide opportunities for the research students to conduct their studies. The rooms are with private toilets, shower and other facilities will be available for the patient.

The mission of the organization of economic co-operation and development (OECD) has presented a statistics of the beds for the inpatient per year compared to the other EU countries. According to their indicator Sweden has 2.5 beds available for one thousand inhabitants, are maintained, available and with the medical staff. The Stockholm county council project for the construction of NKS and extension of the Huddinge Hospital plays important role for the future indicator of the beds services per thousand inhabitants. The figure below hospital beds with services for the year 2015:
4.3.2. Planning and Logistics:

The movement and waiting in the healthcare has direct impact on the safety and quality of the patient. The logistics with a good flow of processes is based on the planning, design, management and check on the process steps. In the healthcare the logistics can be easily understood by taking the chain of flow into two: One an internal and second as external chain. The no lead time service is the goal of the internal chain of the logistics which can significantly improve the service level. The improvements in the external chain of processes can reduce the costs. The overall management of the internal and external chain of processes is the sources of improvement in the wards, operating rooms, inventory, patient satisfaction, job performers and the work is performed efficiently (Zhi Xiong Pan & Shaligram, 2007).

The logistics in the NKS has been planned thoughtfully so there is minimum movement of patient and staff. They have improved the management systems of information, transportation of patients internally as well as externally, food and medication services. The single rooms are

Figure 11: A bar chart indicating the beds available per one thousand inhabitants compared to other EU countries by OECD Data. (2016)
located to the same floor near to the wards. The area of the admitted patients and medical staff are separated from other public visiting hospital. There are separate hallways and elevators for the movements of the admitted patients. This will have direct impact on the reduction of the unwanted Lean factor which is *motion*. Besides that the imaging and the functional diagnostics will be located at the strategic positions in the building near to the wards so the patient has not to wait for their x-rays, MRI or CT scan to be carried out, this is reduction in the waiting time.

The transportation of the materials to the different wards/sections of the hospital will be handled by the robotics. There will be mobile robots in the warehouse of the hospital which will supply materials within the wards such as sheets, clothing and other basic needs stuff. These robots will deliver stuff using separate elevators controlled by a service person so to avoid any defect. This is smart logistic plan will make the need of the large *inventories* useless. All the orders will be made electronically so the medical staff will have good time to focus on the patient treatment.

The NKS will be interconnected with the pneumatic tubes that will increase the efficiency and effectiveness of the patient medical treatment. The network of the pneumatic tubes will help in the safe transportation of the medicine, blood bags and laboratory tests with in the hospital which will reduce *errors* and *waiting* time.
4.3.3. Medical record/IT at the NKS:

The medical reports play vital role in the patient health treatment processes. The use of IT compare to the traditional paper work can provide effective, efficient and quality of healthcare. The use of IT for the medical records and making it an integral part of the healthcare needs complete support of three stakeholders: The patients, healthcare professional and the society as whole. Several case studies have been made which shows potential advantages by using IT for the medical records such as, Limiting access to the authorized personnel which increases the privacy, treatment records can be accessed from the different locations any time and different user can access simultaneously, repetition of tests and medication can be avoided, different tests results can be accessed by other health professional for further advise and this
can significantly shorten the waiting time (Alkureishi et al., 2016; Lippert & Kverneland, 2003).

In the case study of NKS we learned that all the medical record at the NKS will be saved electronically. The technology will keep the reports safe and can be studied whenever needed and all the related medical staff will have access to them. The reports will not only help in the follow-up between medical staff and patient but will help for the research studies. The usage of the IT in the record keeping will reduce the defects, over-processing and waiting times.  

4.3.4. New emergency and thematic care center:

The emergency care in the healthcare safety is significant factor for the patient satisfaction. Right treatment on the right time can save many lives within the good response time.

In our case study, for the patient safety and care at the NKS new emergency department has been designed according to the needs of the trauma or seriously ill patients. The trauma patients rooms are located near the laboratories and surgery rooms which avoid the patient movements and waiting for the test required prior to surgeries or treatment. There are two helipads where two helicopters can land and take off as well as separate entrance for patients coming via ambulances.

There several thematic care at the NKS which includes Cancer, Cardiovascular, Neurological, Inflammatory, Reparative medicine and Pediatric. In case of the cancer needs to consult several specialists and several tests are conducted before any treatment. For the cancer patients it usually takes weeks for the consultation, examination and tests which will be done in one day at the newly designed NKS. This new process for the cancer patient will also have the diagnosis, the treatment plan and appointment for the commencement of the treatment. The occurrence of all chain of activities is due to the proximity of the all function in the NKS resulting in the patient safety.
4.3.5. People-friendly and sustainable:
The indoor environment of the hospital and wards help in the healing process of the patient. This helps in the reduction of the stress as well as provides patient safe environment to take proper rest and medication. The indoor environment in the NKS is people-friendly, attractive that gives good feeling to the patients and working staff. The building interior has bright colours/painting, light weight and designed with the Scandinavian materials. The interior will give good feeling to the patients and direct them easily to reach their desired department without the time wastage. Sustainability is strategies and policies to minimize the environmental impact on the present and future generation. During the construction and after the completion, the operation of the NKS will be conducted under the sustainable environment.

4.4 Karonliska Neonatal:
In Sweden the processes for the treatment of the patients are very well defined and followed. Similar to the other public services the healthcare is one of the services which is decentralized and county council as well as the municipalities are the ones who take care of the healthcare services. According to the Swedish healthcare Act, Goal of the healthcare is to give good healthcare on the equality basis and those who need care first must be treated as such (Beata Kollberg et al., 2007). In almost all the healthcare facilities the patient goes through the process flow which is as follows:

![Figure 13: General Process flow of a patient in the Sweden](image-url)
In our case study we have chosen the Neonatal department that belongs to the Astrid Lindgren child hospital and works under the Karonliska University hospital. The Neonatal department takes care of the sick and premature new born babies. According to the recent data of the Organization for Economic co-operation and development (OECD) the mortality rate (deaths per 1000 lives) is 2.2 for Sweden whereas lowest is 1.8 for the Finland as shown in the figure no.14 below. The mortality rate data is for the children under the age of one year, low mortality rate reflects the quality and midwifery safety of healthcare. Sweden is struggling with the figures and trying their best for the quality and safety of the child birth. The Neonatal at Karonliska is among the largest hospitals and is located at the three different municipalities Solna, Danderyd and Huddinge. The Neonatal department at all of the three hospitals Solna, Danderyd and Huddinge municipalities have the facilities of the emergency and intensive care and can take good care of the sick, premature new born babies. The Neonatal department at the all the three municipalities is under the management of the Astrid Lindgren child hospital at KI. All the three children hospitals in Stockholm län work independently but do share their research findings and experiences towards the best possible healthcare.

*Figure 14: Mortality rate of Sweden compared to Finland from OECD health status OECD Data. (2016)*
4.5 Preterm and Sick Newborn Children Treatment Groups:
In the Neonatal department the childcare is divided into the three different groups. Each group of new birth is given treatment and care according to the level of severity in health treatment needed. The severity of treatment can be explained by the colours shown in the risk level table: Red is for the extreme risk level, Yellow represents high risk level where as Green is for low. The child born in less than 28 weeks is considered as extreme preterm birth the risk level is extreme and is marked Red. The children with extreme preterm birth with the risk level marked Red need full care are placed in the First group. The new born babies with critical illness related to Brain, heart, stomach, urinary, intestine tract etc. are kept in the Neonatal intensive ward with the intensive care and according to the Risk level are marked Yellow. The Yellow marked group of children are named second group. The third group consists of the moderate preterm children and the full term sick children. Even though their risk level is marked green they are kept under observation of minimum of 24 hours. This can be shown in the figure below:

*Figure 15: Patient Groups- Preterm & Sick newborn babies. Left side is the Risk level table*
4.6 Flow Chart of Preterm and Sick (Newborn) Children:
The Astrid Lindgren Neonatal department at Ki has done visual mapping for the preterm child birth. According to the flow chart shown in the figure there are two groups of children one born at the Ki and other born at another hospital. Taking the children with preterm birth at the KI, the decision is made by the doctor and nurse to send the child to neonatal care unit. In Neonatal care the head doctor together with the head nurse according to the child care assessment is placed further in one of the three wards. The children with birth less than 28 weeks are placed in the intensive care unit where as children having infections, heart, and brain or lungs etc are placed in the intermediate ward. Similarly, the preterm births in any other hospital are directed to the KI where the head doctor and nurse take the responsibility of the child. During the whole process of care parents have full access to the reports and progress of the child. They are involved in the decisions made as well as further steps are taken on their satisfactions. After the complete health treatment child are discharged from the hospital with the consultation of Neonatal board which includes head doctor, nurse and parents. It is the board who decides if the child discharged to home will be under observation by the neonatal nurse or will be without care depending on the health situation. In the end of the flow chart children discharged from the Neonatal care are attended by the frequent visits of the nurse from the neonatal until they are safe and health for movement.
Figure 16: Flow chart of the Preterm and Sick Children treatment at the KI (Astrid Lindgren) Hospital

(Was made using Microsoft Visio 2010)
4.7 Organizational Changes in Neonatal Department:

The successful Lean implementation in any organization, is how receptive and flexible is the organizational culture. Lean implementation is to make the processes free from the non-value adding activities as well as making the processes fail free to lead towards the continuous improvement. This can only be achieved by the full support of the job performers under the supervisions and approval of the higher management. Most of the employees fear of the Lean implementation as they consider this as reduction and jobs cut. The very basic tool for getting the support and active response of the job performers is communication. Communication is significant for the manager as it helps them to satisfy, clarify the concerns of the job performers so to reduce the lead time and work smoothly. After the employees awareness of the Lean, discussion forum should be open for them and their input is appreciated which will increase their confidence and trust. This will also remove the silos in departments as well as in an organization as whole and culture of continuous improvement and openness will be established (Beata Kollberg et al., 2007; Tsasis & Bruce-Barrett, 2008).

In our case study we studied the organizational changes in the Neonatal department of the Astrid Lindgren children hospital at NKS. The Astrid Lindgren is located in the three municipalities of Solna, Danderyd and Huddinge. They are under the supervision of the one Chef Doctor and each of the three locations is supervised by the three chef nurses. With the construction of the NKS the organizational structure is more improved by increasing the communication and research sharing between the three hospitals. They have decided that the all the three hospitals located at the three different municipalities will be head by one chef nurse. To work more effectively they agreed on the monthly meeting between the three hospital lead by the chef doctor Chef Nurse, Quality controller and other related persons etc. shown in the figure no. 17 below. This will help them to communicate, share and plan the health treatment procedures and
schedules. The monthly meeting of the three hospitals will help them to remove silos as a result will work effectively and efficiently.

Figure 17: Example of responsible persons (including doctors, nurses and administrative staff) in the monthly meeting of Astrid Lindgren child hospital

Their main objectives are as following:

- Well defined patient groups with the patient flow manager
- Team all those involved in the patient treatment and those involved in the patient flow and defining output measure. As a result work will be integral part of the business meeting
- This team will be involved in the relevant measures needed and select the dimensions of work.
- Outcomes control the improvements and operational improvements. Flow manager reaches the outcomes and activities linked to the operation scorecards. Work is anchored in all operations
- Flow manager follow up line managers for the results and in while patient groups drives charts in implementation phase
Chapter 5
Conclusion and Suggestions:

In this chapter we will conclude the work carried out in the thesis project by considering the above mentioned results, analysis and discussions. Further we will also propose the directions for the future research which were highlighted during and after the completion of the project. Those highlighted areas or directions were not completed due to the limitation of the thesis work.

The main objective of the thesis was to study the impact of Lean in the Design, reconstruction and organizational behavior in healthcare. Firstly, we have carried out the research study in the lean and its impact on the healthcare processes. We studied several LEAN healthcare cases of US and UK including the Swedish hospitals, their impacts on patient safety, quality and effective treatment.

Secondly, we selected a case study of Karolinska hospital as they were working on the project of NKS (Nya Karonliska Sjukhus). NKS is the construction and redesign of the Karonliska Hospital in which they have introduced state of art machinery and lean tools for the betterment of patients and their safety. We have done qualitative and quantitative research of our case study and from that we conclude that different lean waste such as transportation, motion, waiting time, inventory etc. are reduced to significant extent. This has significant impact in terms of efficiency, effectiveness and safety as well as quality on the three stakeholders of the healthcare (patients, administrative staff, doctor/nurses) due to this construction, re-designing and Lean implementation, specifically patients and public.

Thirdly, for further study of significance of organizational behavior in lean implementation, we chose neonatal department of Astrid Lindgren Children Hospital. We found through our study that a silo phenomenon was a major cause of treatment effectiveness that has been resolved in NKS. Through value stream mapping the patient flow has been investigated which highlighted the patient flow in NKS.
Lastly, for future research we like to suggest selecting and studying a department in NKS where they are facing problems like overcrowding, long waiting time etc. We suggest to use lean tools such as value stream mapping (VSM), 5S etc to identify, reduce and eventually remove the non-value adding wastes in specific department.
References


## Interviews

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<td>Face-to-face</td>
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<td>Interview 02 (10 jun 2016)</td>
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<td>Face-to-face</td>
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<tr>
<td>Interview 03 (1 july 2016)</td>
<td>Chief Nurse Neonatal Department Karonliska Hospital</td>
<td>Face-to-face</td>
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<td>Interview 04 (20 may 2014)</td>
<td>Showroom coordinator Skanska New Karonliska Hospital</td>
<td>Face-to-face (informal)</td>
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## Events

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<td>Seminar (24 may 2014)</td>
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<td>NKS Show Room Visit (08 july 2016)</td>
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