

Development of an Implementation Plan for Six Sigma within a Swedish Healthcare Context

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Sammanfattning

Det ligger i sjukvårdens natur att ständigt förbättra sin verksamhet för att skapa den bästa möjliga vården för sina patienter. Region Östergötland är en del av svensk sjukvård och har identifierat att de saknar en förbättringsmetod som med fokus på statistiska analyser av data. Då Region Östergötland tidigare genomfört ett antal Six Sigma projekt i samarbete med Linköpings universitet, upptäckte de att Six Sigma kan vara den metod de efterfrågat. Region Östergötland önskar därför få en djupare förståelse för hur Six Sigma kan implementeras framgångsrikt i deras organisation.

Syftet med examensarbetet var att undersöka hur Six Sigma kan implementeras på Region Östergötland genom att skapa en implementeringsplan. För att uppfylla syftet genomfördes en litteraturstudie följt av två fallstudier. Syftet med litteraturstudien var att identifiera hur Six Sigma kan implementeras samt vilka framgångsfaktorer som bör beaktas vid implementeringen. De två fallstudierna syftade till att skapa en koppling mellan resultaten av litteraturstudien och svensk sjukvård. Den första fallstudien genomfördes på Skaraborgs sjukhus, vilket är den enda dokumenterade fallet av en Six Sigma implementering inom svensk sjukvård. Den andra fallstudien genomfördes på Region Östergötland, som tidigare genomfört Six Sigma-projekt i samarbete med Linköpings universitet. I fallstudierna studerades dokument, intervjuer genomfördes, och verksamheterna observerades.

Med hjälp av litteraturstudien och de två fallstudierna kunde de kritiska framgångsfaktorerna för implementering av Six Sigma inom svensk sjukvård identifieras. De identifierade kritiska framgångsfaktorerna lade grunden för en implementeringsplan i 15 steg för en kommande implementering av Six Sigma på Region Östergötland.

Abstract

It is in the nature of healthcare to improve its operations to enable the best possible care for its patients. Region Östergötland, who is a part of Swedish healthcare, has discovered that they lack an improvement method that is based on statistical analyzes and data. By previously carrying out a few Six Sigma projects in collaboration with Linköping University, Region Östergötland discovered that Six Sigma can be the method they are searching for. Region Östergötland therefore wants to gain an understanding of how to successfully implement Six Sigma.

The purpose of the thesis was to investigate how Six Sigma can be implemented at Region Östergötland by developing an implementation plan. This was done by conducting a literature study followed by two case studies. The aim of the literature study was to identify how Six Sigma should be implemented and the critical success factors that should be considered in the implementation. The case studies aimed to create a connection between the results from the literature study and Swedish healthcare. The first case study was therefore conducted at Skaraborg Hospital Group, which is the only documented case in Swedish healthcare where Six Sigma has been implemented. The second case study was carried out at Region Östergötland, where the Six Sigma projects that they previously carried out together with Linköping University were studied. The case studies were conducted with help of document studies, interviews, and observations.

The literature study and the two case studies identified the critical success factors when implementing Six Sigma within a Swedish healthcare context. The identified critical success factors were the basis of the 15-step implementation plan for how Region Östergötland should implement Six Sigma within their healthcare operations.

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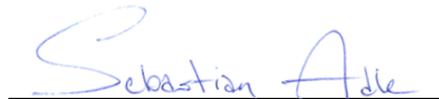
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Abbreviations

BB	Black Belt
CSF	Critical success factor
DMADV	Define, measure, analyze, design, and verify
DMAIC	Define, measure, analyze, improve, and control
GAVA	Geriatric emergency department
GB	Green Belt
KPI	Key performance index
MBB	Master Black Belt
MSK	Medical specialist clinic
PM1/PM2	Project manager 1/Project manager 2
SALAR	Swedish Association of Local Authorities and Regions
SkaS	Skaraborg hospital group
SKF	Swedish ball bearing company
STECO	Steering Committee
VGP	Value Generation Program
WB	White Belt
YB	Yellow Belt

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1. Introduction

This chapter provides an understanding of the project's background and associated problem description. In addition, the purpose and the research questions for the thesis are also presented. Scope, limitations, and delimitations are also addressed to clarify the limitations of the work.

1.1 Background

Quality management in healthcare is various well-established practices that dates to as early as 1914 (Caldwell & Varkey, 2021). Since its establishment, several different tools and techniques have been tested and implemented in the healthcare sector with the shared goal of improving various parts within it. One of the efforts used is the quality improvement method called Six Sigma. Six Sigma is a method used to reduce variation or defects in a process, as well as a strategy with the goal of being as efficient as possible (Brue & Howes, 2006).

Region Östergötland's main responsibility is to provide the inhabitants with health- and dental care (Rundgren, 2022). The region is also responsible for ensuring long-term and sustainable development in areas such as community building, skills supply, entrepreneurship, hospitality, culture, public education, and public health. Furthermore, the region is also managing the public transportation, as well as the development within this sector.

Region Östergötland stands out as one of the most efficient regions in Sweden (Sveriges Kommuner och Regioner, 2021). The report shows that the region has good results in the areas of medical quality, accessibility, and patient experiences, while the costs are low compared with most other county councils and regions in the country. The cost of running the health and medical care for Region Östergötland is approximately 14 billion SEK per year (Bjäresten, 2021). A continued development of working methods and processes in their healthcare operations thus has great potential benefits in terms of both financial savings, increased patient safety, and quality of healthcare.

Region Östergötland has recently drawn attention to the fact that healthcare development processes are often based on varying working methods with low weight in historical data. The region also tends to collect a large amount of data without knowing how the data can be used for effective improvement work based on statistical analyzes. It is in Region Östergötland's interest and nature to strive for continuous improvement and new methods, that can help achieve maximum economic efficiency and the best possible healthcare.

1.2 Problem description

Even though Region Östergötland's current development efforts are very successful, the drive to keep improving comes with the need of finding new ways of working. This, together with the desire to have statistics be more thoroughly embedded in the development process, led the region to look at Six Sigma to be implemented as a new additional process improvement method. Region Östergötland wants to ensure that the implementation is successful by identifying the critical success factors of a Six Sigma implementation and mapping out what competencies that is needed on the different levels in the region's organization.

1.3 Purpose

Region Östergötland have identified the need of a data-driven improvement method in order to improve their healthcare further. Therefore, the purpose of the work is to review and develop an implementation plan for how to successfully implement Six Sigma within a Swedish healthcare context.

1.4 Research Questions

RQ1 – What critical success factors are required for a successful implementation of Six Sigma within a Swedish healthcare context?

RQ2 – What critical success factors have Region Östergötland identified as necessary, based on their experiences from previous Six Sigma projects?

RQ3 – How should an implementation plan look like when implementing Six Sigma at Region Östergötland?

1.5 Scope and limitations

To ensure that the thesis is grounded and focuses on the correct areas, some limitations need to be done. The limitations are:

- The thesis will only use experiences and knowledge from two Swedish healthcare organizations.
- No new Six Sigma project will be carried out. Instead, results and experiences from previous Six Sigma projects at Region Östergötland will be used as empiric studies, focusing on the working process rather than the end results of the projects.
- The thesis will describe what critical success factors (CSF) that are important and how the organization should be structured when implementing Six Sigma but will not perform the implementation.
- Implementation strategies and recommendations included in the project are primarily intended to suit healthcare and not necessarily all other parts of Region Östergötland's operations.

2. Methodology

This chapter aims to clarify which methods that will be used within the thesis. An explanation of each step in the thesis will be given along with a reasoning why the steps were included. Lastly, the ethical consideration, validity, and reliability of the thesis is discussed.

2.1 Overall Research Methodology

The workflow of the thesis was divided into eight different parts and is presented graphically in Figure 1 below. The problem was first defined to determine the direction of the thesis. The literature was then studied to create a frame of reference. Based on the frame of reference, a case study was conducted at Skaraborg Hospital Group (SkaS) to review their implementation of Six Sigma. The literature study and the empirical data from SkaS were then analyzed to answer the first research question. To answer the second research question, an additional case study was conducted, this time at Region Östergötland. In the last step, the findings in the literature and the two cases were combined, and the results from these were presented and expanded upon in development workshops at Region Östergötland. This finally resulted in an implementation plan for Six Sigma at Region Östergötland.

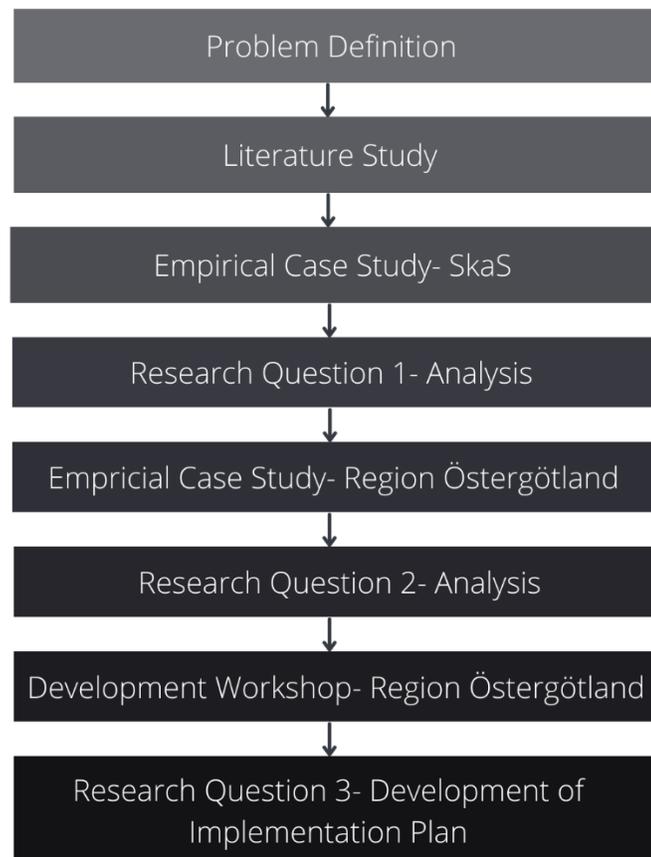


Figure 1. Research design of the thesis.

In research methodology, a distinction is made between quantitative methods and qualitative methods (Andersen, 1994). The authors defines that quantitative methods are synonymous with the fact that what is studied can be measured and presented numerically. He further describes that qualitative methods, on the other hand, have their starting point in that each phenomenon consists of a unique combination of properties and qualities. This means that the result cannot be measured numerically but instead is assessed on a more subjective level. In this work, qualitative methods have been used as the work is based on studying literature and combining it with two case studies. The result presented is therefore of qualitative nature.

Söderbom & Ulvenblad (2016) claims that there are three different ways of working when conclusions are to be drawn from an empirical study. The authors refer to this as approaches, in terms of, deductive, inductive, and abductive approach. A deductive approach means that the researcher starts from what others have written, i.e., previous theories, asks questions about this and possibly formulates hypotheses that are to be tested in an empirical study. A deductive approach was used for this work as the literature formed the basis of the work. What emerged in the literature was then compared with the results of the two case studies.

A more detailed description of the thesis working process, ethical considerations, validity, and reliability presented in chapter 2.2 below.

2.2 Literature Study Methodology

The literature study began immediately after the problem formulation was defined. The purpose of the literature study was to acquire necessary knowledge in the areas concerned, to later be able to answer the research questions of the work. The material reviewed consisted of scientific papers, books, and publications by Region Östergötland and the Swedish Association of Local Authorities and Regions (SALAR). Relevant books and articles were found primarily with the help of the search engine belonging to Linköping University's library. Secondly, the search engines Google Books and Google Scholar were used. To facilitate the study of the literature, the main areas that were considered important to answer the work's research questions, were determined. The three main areas that were studied was Six Sigma Critical Success Factors, Implementing Six Sigma, and Six Sigma Infrastructure and Roles (Belts). To break down the three main areas into smaller components, several key words were used when searching for literature. To name a few, the following were the most used keywords:

- Six Sigma
- Implementing Six Sigma
- Six Sigma Critical Success Factors
- Six Sigma in Healthcare
- Six Sigma Belts
- Six Sigma infrastructure

Critical Success Factors, Belts, and Infrastructure are well-known topics within Six Sigma that are widespread in the literature. A large amount of literature and sources placed high demands on conducting the literature review in a structured way. One of the challenges was to create an image of what is addressed most frequently in the literature. Therefore, a large amount of literature was studied where the various critical success factors and belts mentioned in the literature were compiled into two tables, which are presented in chapter 3. In this way, an image was created about which different aspects occur most frequently in the literature. To further visualize this, a bar chart was created containing the most frequently mentioned critical success factors, also presented in chapter 3. The factors that were mentioned most often in the literature were then explained in more detail in accordance with what the sources discussed.

2.3 Empirical Case Study

Six Sigma in healthcare is not as widespread in the literature as critical success factors, infrastructure, and belts, especially not in a Swedish context. This led to that the small number of sources regarding Six Sigma within Swedish healthcare were studied at a more detailed level. Information and experiences from Swedish healthcare were obtained from two different organizations: Region Östergötland and Skaraborg Hospital Group. These two organizations were used as case studies in the thesis.

To collect data for the empirical case studies, a triangulation approach was used, more specifically data triangulation. Yin (2018) defines data triangulation as converging multiple sources of data into one set of findings, rather than analyzing the sets of data separately. The different sources of data, which varied in the two cases, were interviews, observations, and documents. To ensure that the empirical data required to answer the research questions was collected, a data collection plan was created. Table 1 shows a summary of the data collection plan.

Table 1. Summary of the data collection plan.

Stakeholders	Titles of Subjects	Investigation Tool/Duration	Objectives
Skaraborg Hospital Group	Svante Lifvergren: Development Director	1 interview á 90 minutes	To gather information about experiences from the implementation of Six Sigma at Skaraborg Hospital Group and compare these with CSF from the literature.
Skaraborg Hospital Group	Alexandre Chakhunashvili: Master Black Belt	1 interview á 40 minutes	
Region Östergötland	PM1: Care Developer	1 interview á 90 minutes	To gather information about experiences from previously completed Six Sigma projects at Region Östergötland and compare these results with CSF from the literature.
Region Östergötland	PM2: Care Developer	1 interview á 90 minutes	
Region Östergötland	4 Business Developers 1 Development strategist 1 Development manager	3 workshops á 90 minutes	To anchor/discuss what has been found in the literature to make it fit within Region Östergötland's context.

Interviews, observation, and document reviews were conducted at Region Östergötland and Skaraborg Hospital Group as part of the data collection. The purpose of the work was to compare theory with previous experiences from Six Sigma projects and the implementation of the Six Sigma methodology. Development workshops were also used to anchor the findings from the literature at Region Östergötland. Further explanation of the two case studies follows below.

2.3.1 Empirical Case Study - Skaraborg Hospital Group

Skaraborg Hospital Group is the only Swedish hospital group that is mentioned in the literature regarding implementation of Six Sigma. They have implemented Six Sigma as an improvement method in Swedish healthcare and was therefore a valuable organization to study. The work with the implementation was documented through scientific articles written by those

responsible for the implementation and material published by SALAR. The data collection methods that were used in the SkaS case are described in detail below.

Document review

In the first step of the case study, a review was carried out of the material that has been written about the implementation of Six Sigma at SkaS. A list of the publications reviewed can be found in Table 2 below.

Table 2. List of the written sources used for the case study at SkaS.

Title	Source
Lessons from Sweden's first large-scale implementation of Six Sigma in healthcare	(Lifvergren, et al., 2010)
Improving 'Improvement' by Refocusing Learning: Experiences from an -Initially- Unsuccessful Six Sigma Project in Healthcare	(Lifvergren & Bergman, 2012)
Six Sigma i hälso- och sjukvården	(Sveriges Kommuner och Landsting, 2008)

As a deductive approach was used for the thesis, the review was based on the CSFs that were identified from the literature. The SkaS material was therefore examined with the aim of comparing whether the CSF identified in the literature correspond to the case material or not. It is worth mentioning that the material from SkaS does not specifically focus on CSF as such. To identify similarities and differences, the material was therefore examined at a detailed level to find information that fits the respective CSF. The analysis thus consisted of summarizing the various publications and categorizing the information under the correct CSF. Through the analysis work, it was clear to see which CSF that were important at SkaS and whether these correlates with the literature or not.

Interviews

To create a deeper understanding of the implementation of Six Sigma at SkaS, two interviews were conducted with employees from the organization. The interviews were conducted in accordance with Table 1 above.

Lexell & Brogårdh (2020) states that researchers in qualitative studies often make a strategic selection of participants, i.e., decide how the participants should be selected. According to the authors, the goal is to include participants who have different experiences. In the case study at SkaS, two interviewees were selected from the organization through a strategic selection. Below follows a more detailed explanation of why and how each interviewee was selected.

The first interviewee was Svante Lifvergren who worked as development management and was one of the people responsible for the implementation of Six Sigma at SkaS. He has a background as a medical doctor and has worked for a long time with development and improvement in the medical field. Lifvergren is one of the authors of the articles written about the implementation of Six Sigma at SkaS and was therefore considered a valuable resource for

this thesis. The authors were able to ask questions about what is addressed in the articles but also about experiences that are not mentioned in the articles. This can give a broader understanding of the implementation at SkaS and give valuable information to the thesis. The latest article published about the implementation at SkaS was published in 2010. This means that Lifvergren, who still works at SkaS, possesses valuable information about how the work continued from 2010 until now. This was also considered to be one of the main reasons why Lifvergren was selected as one of the interviewees.

The second interviewee were Alexandre Chakhunashvili, who at the time of the implementation of Six Sigma at SkaS worked as a Master Black Belt (MBB). As Master Black Belt, he was responsible for educating, coaching, and ensuring that the Six Sigma projects worked as intended. He had a clear operational role in the projects and was a co-author of the articles that dealt with the implementation. Chakhunashvili was considered a valuable source of information as he worked on the front lines of implementation. He worked closely with the staff who carried out the projects and thereby possesses solid knowledge about the implementation.

Björklund & Paulsson (2003) claim that interviews can have a semi-structured character, which means that the subject areas are predetermined but that the questions are formulated during the interview based on the respondent's answers and reactions. By using a semi structured method in the interviews in this thesis, an open climate was created where the interviewees had a chance to highlight what they thought was most relevant. However, an interview guide was used to create a foundation and ensure that we got all the necessary info. The interview guides can be found in Appendix 1 and Appendix 2 respectively.

Both interviews were conducted digitally, and notes were taken during the meetings. To make it possible to take part of the interviewee's answer again, the interviews was recorded. The analysis of the interviews was carried out by categorizing the answers based on the CSFs identified in the literature study.

2.3.2 Empirical Case Study - Region Östergötland

Region Östergötland has previously collaborated with Linköping University and thereby run several Six Sigma projects. Two employees from Region Östergötland were interviewed to gather information about positive and negative experiences about the previous Six Sigma projects. One of the previous projects was carried out together with the authors of this thesis as a part of a university course. Therefore, the authors' observations from the project are also summarized below.

Interviews

To collect data on what went well and badly in the projects previously carried out at Region Östergötland, two employees from the organization were interviewed. The length of the interviews, who participated, and what the objective was, is shown in Table 1 above.

Like the interviews at SkaS, a strategic selection of the interviewees was made. Below follows a more detailed explanation of why the two interviewees were selected.

The first interviewee was involved in the Six Sigma project at Region Östergötland which was carried out in collaboration with the authors of this thesis. The interviewee selected was responsible for making the Six Sigma project's operational work at Region Östergötland run as intended. When the project was carried out, the person in question worked as a care developer at the medical specialist clinic (MSK). By being part of the Six Sigma project at Region Östergötland, the interviewee has significant experience of what went well and badly when the project was carried out. As a care developer, the person also has sufficient knowledge about the organization, improvement methods, and strategies used today.

The second interviewee was contacted because of a recommendation from the client Johan Ljungqvist at Region Östergötland. The interviewee has previously been responsible for two other Six Sigma projects that were carried out in a collaboration between the Östergötland Region and Linköping University. The person had the overall responsibility for the execution and implementation of the projects. Daily, the interviewee worked as a business developer in medical technology. The person was selected based on her previous experiences with Six Sigma projects at Region Östergötlands and the role as a business developer.

In accordance with the interviews at SkaS, semi-structured interviews were used. The interview guide used can be found in Appendix 3. The interviews were conducted digitally where notes were taken during the meeting. They were also recorded to make it possible to review the answers afterwards. The analysis was done by categorizing the answers based on the success factors previously identified in the literature study.

Observations

The authors of this thesis led a Six Sigma project at Region Östergötland and the experiences and observations from that project are important for this work. We therefore summarized the observations that we took part in together during the work. This was done by together we highlighted the most important findings that we took part in during the project. To make the observations clear, more text was added that explains the different points that were identified.

2.4 Analysis method

Pattern matching is defined as comparing patterns in empirical data with a pre-defined pattern from before the data collection (Yin, 2018). Furthermore, the approach can also strengthen the internal validity of the results. The analysis for the first two research questions was done following a pattern-matching logic. The reason for using this analysis method was to find similarities and differences in the theoretical and empirical findings.

2.4.1 Research question 1

When analyzing the data for the first research question, the pre-defined pattern came from the literature study that was performed beforehand. The pre-defined pattern from the literature study was the critical success factors that was mentioned most frequently. Using the pre-defined pattern, the empirical data collected was then compared to it to find similarities and differences. The goal of using this approach was to accurately answer the question of which critical success factors is needed for a successful Six Sigma implementation.

2.4.2 Research question 2

The same approach was used when analyzing the data for the second research question. This time, however, the pre-defined pattern, again of critical success factors, came from the analysis of the first research question. The empirical findings from the second case study were then compared to that pattern, again to find similarities and differences. By doing this analysis, the second research question could be answered.

2.5 Development of Implementation Plan

The development of the implementation plan was performed in three steps.

Firstly, an analysis of the frame of references was conducted. The analysis aimed to break down the CSF into smaller segments and find concrete actions connected to the identified CSF. Some of the actions found in the analysis were then visualized by developing a process for it when it was necessary. All actions and processes found in this step has one common goal, to identify and clarify what is needed to be done to ensure that the CSF are fulfilled.

The second step was conducting development workshops with representatives from Region Östergötland. In total there were three development workshops held over three weeks, one workshop per week. The duration of the development workshops and who attended them is presented in Table 1 on page 6. The purpose of having development workshops were to further break down the actions and processes identified in the previous step to make them better fit Region Östergötlands organization and way of operating.

In the final step of developing the implementation plan, the findings from the first two steps were used. The actions and processes identified and developed in the previous two steps were included when compiling it into an implementation plan. Inspiration was taken from two other Six Sigma implementation plans together with the actions and processes ensuring that the CSF can be achieved.

2.6 Ethical considerations

Merriam (2009) mentions that it is important to protect the participants in a qualitative study as they are a concern for ethical issues. Bryman (2012) argue that researchers of a study should always anticipate and counteract the ethical concerns in advance. The author addresses the following four ethical principles that should be considered when conducting qualitative case studies (Bryman, 2012, p. 135):

1. Whether there is harm to the participants;
2. Whether there is a lack of informed consent;
3. Whether it is an invasion of privacy;
4. Whether deception is involved.

The above principles were used to consider the ethical issues that arise in interviews. The interviews conducted with employees from the case at Region Östergötland were therefore treated confidentially. Their names are not written in the thesis, but aliases are used instead

when the respondents are mentioned. The reason for this was to give the interviewees the opportunity to answer the questions as openly as possible and to make it easier for them to share both positive and negative experiences of the operations. This without exposing the interviewee to any risks of being questioned for their answers at their workplace.

The interviewees from SkaS are authors of the articles published about the implementation of Six Sigma at SkaS. As the authors' names are already public through the published articles, there is no reason to treat these individuals confidentially.

Before the interviews, oral and written information about the purpose of the interviews was also provided and each participant gave their written informed consent. The interviews were recorded digitally, which the interviewees received information about and were given the opportunity to approve or not. The interviewees were also informed that some of the material from the interviews will be published in the thesis. It was also agreed that the information included from the interviews in the thesis will be sent out to the interviewees before publication for comments and approval.

Invasion of privacy is not considered a problem in this work. The interviews that were conducted dealt with questions about the participants' perceptions of the work at Region Östergötland, not their private lives. All communication with the participants and the organization was also made as honest and clear as possible to prevent anyone from feeling exposed to fraud. Part of reducing the risk of this was to send out the answers from the questions to the participants for approval.

2.7 Validity and Reliability

To ensure quality throughout the thesis, different aspects of both validity and reliability need to be taken into consideration. How those areas were to be addressed in this thesis is described below.

Construct validity

Construct validity is described as sufficient set of operational measures being set up when collecting data, to avoid subjectivity (Yin, 2018). The author identifies two different tactics that can be used to ensure construct validity: using multiple sources of evidence or having key informants review a draft. In this thesis, construct validity is ensured by using data triangulation i.e., combining findings from multiple different sources, when collecting data. The findings in the case studies came from different sources, namely interviews, observations, and documents.

Internal validity

The cause and effect of two events, and specifically how and why one can claim that it occurs with support of evidence, is called internal validity (Yin, 2018). There are several different tactics to achieve this according to Yin (2018), with one of the tactics being pattern matching. This tactic was used in the analytic phase of the thesis. By comparing and contrasting the different sources with the aim of identify patterns in the data the concern of internal validity was addressed. Additionally, in this work, all interviews were recorded after the participants' approval to strengthen the validity of the results. At the same time, notes were also taken by

both interviewers to further ensure that the correct information was collected. The material summarized from the interviews was sent out to the participants before publication to reduce the risk of misconceptions. The changes suggested by the interviewees were then made.

External validity

Yin (2018) describes external validity as if the study can be generalized beyond the scope of the study. Using theory in single case studies and using replication logic in multiple are two tactics that the author presents to handle external validity. In this thesis theory have been used in the analytic phase of the case studies by laying a solid theoretical foundation in the literature study and then using that foundation when analyzing the findings in the case studies. However, replication logic has not been used for the two case studies. The reasoning behind this was that the two cases differed greatly and were best examined separately.

Reliability

Yin (2009) argues that high reliability is realized when a study achieves the identical results and conclusions when the same method is used again. Furthermore, the author writes that the reliability of the data tends to change in a qualitative study because the environment, setting and time may affect the result. Yin (2009) therefore claims that all steps in the method should be carefully documented to achieve a high level of reliability. Merriam (2009), on the other hand, emphasizes that qualitative research studies should record the data and continuously analyze the results. This was achieved by analyzing the data collected in different steps throughout the work, starting with the literature study, continuing through both case studies and the development of the implementation plan.

Since this thesis is carried out by qualitative method, it makes it difficult to achieve a high level of reliability. To ensure a high level of reliability, a clear focus has been placed on documenting the method clearly to show how the work has been carried out. Something that should be emphasized is that the interviews have not been transcribed, but the most important conclusions from the interviews can be found in the analysis section.

3. Frame of Reference

In this chapter a literature study is conducted to create a frame of reference for the thesis. The chapter focuses on specific Six Sigma areas that is required to answer the research questions. Those areas are critical success factors, infrastructure, roles, and implementation.

3.1 Six Sigma

Six Sigma is a structured method of quality improvement with the goal of identifying and eliminating the root causes to problems in a process (Sörqvist & Höglund, 2017). The authors further point out that the Six Sigma method stands out from other quality efforts because the method uses a predetermined project approach that combines both qualitative and quantitative tools. Additionally, Six Sigma is not only a method of which the projects are to be operated with, but also both the goal and the vision (Tennant, 2001).

Six Sigma was first introduced at Motorola in the late 1980s (Magnusson, et al., 2003). Since then, many large organizations have implemented a Six Sigma program. The name originates from statistics and refers to how many defects there is per million opportunities (Brook, 2020). A process that can produce within the six sigma is believed to only have 3.4 defects per million opportunities.

What Six Sigma can be for an organization amounts to many things (Magnusson, et al., 2003). However, it can be wise to acknowledge what Six Sigma is not. Six Sigma will not be the fix to all problems, nor does it guarantee success, and perhaps most importantly, it is not to be mistaken for a simple tool. It requires a great deal of effort and commitment, and specific sets of skills to ensure that Six Sigma will be a successful method.

3.1.1 Six Sigma methodology

In Six Sigma the usual method cycle has five steps: define, measure, analyze, improve, and control (DMAIC) (Brue & Howes, 2006). The DMAIC cycle is used for projects that aim to improve the current processes of a business. There is also another approach: define, measure, analyze, design, and verify (DMADV) that is used when the project aims to create a new product or process (Tennant, 2002). In this report the definitions and characteristics of each step in the DMAIC cycle will be explained.

Define

The define phase is usually the first step in the Six Sigma methodology and aims to identify the problem and build a solid project charter (Vanzant Stern, 2016). To do so, the Define step should determine what is to be achieved with the project, who the customer for the project is, and the characteristics of the current process by creating a process map. This is done to decide if the project is worth investing in before moving on to the next step in the cycle.

Measure

In the Measure phase, the goal is to get a better understanding of the process and how to measure the problem (Brook, 2020). A key aspect of the measure phase is to identify when and where data can be collected and understand what that data represents. Additionally, the

reliability of the measured data must be addressed to establish confidence. It is also important to further expand upon the process map from the Define phase if it is not already detailed enough.

Analyze

The third phase of the DIMAC cycle is the Analyze phase. As the name suggests, the main part of the phase is to analyze the data even further (Brook, 2020). Even if the phase does not follow a logic as strictly as the first two phases, three milestones need to be checked before moving on from the analyze phase. The first is to identify the critical factors for the process, the second is to find potential root causes that cause the defects, and lastly to verify and understand the impact of the root causes.

Improve

After finding and verifying the root causes in the previous phase, in the Improve phase it is time to start generating solutions (Brook, 2020). It is important to come up with a wide variety of solutions to ensure that the best solution, and not just the first one that comes to mind, later can be selected. During the selection process, multiple solutions can be selected or even combined to better address the root causes. The final part of the Improve phase is then to implement the selected solution(s).

Control

In the last phase, the goal is to ensure that the implemented solutions are sustained in the process (Brook, 2020). To do that, a plan should be established that consist of how it should be sustained and who is responsible for it. The solutions need to become standardized in the process before the project can be closed.

3.2 Critical Success Factors in Six Sigma

In Six Sigma, critical success factors are described as key elements for the Six Sigma initiative to be successful (Henderson & Evans, 2000). To find the most important critical success factors in Six Sigma, 41 different articles regarding the topic were studied. How frequent each individual CSF are mentioned in the theoretical material studied are presented in Table 3 below. Additionally, a bar chart was created to show how the CSF are distributed in the literature, see Figure 2.

Table 3. Six Sigma Critical Success Factors listed in the literature.

Success factor	Reference	Total	
		n	%
Management Involvement and Commitment	(Aboelmaged, 2010), (Anand, 2008), (Antony & Banuelas, 2002), (Antony & Desai, 2009), (Antony, et al., 2007), (Brady & Allen, 2006), (Brue, 2002), (Brun, 2011), (Chakrabarty & Chuan, 2006), (Coronado Banuelas & Antony, 2002), (Cronemyr, 2007), (Firka, 2010), (Goh, 2002), (Goldstein, 2001), (Hahn, 2005), (Henderson & Evans, 2000), (Johnson & Swisher, 2003), (Kim, 2010), (Kumar & Antony, 2008), (Kumar, et al., 2009), (Kwak & Anbari, 2006), (Laureani & Antony, 2012), (Leong & Teh, 2012), (Magnusson, et al., 2003), (Pulakanam & Voges, 2010), (Salaheldin & Abdelwahab, 2009), (Szeto & Tsang, 2005), (Taner, 2013), (Timans, et al., 2012), (Wang & Hussain, 2011), (Zu, et al., 2006)	31	76
Training, Education, and Coaching	(Aboelmaged, 2010), (Antony & Banuelas, 2002), (Antony & Desai, 2009), (Antony, et al., 2007), (Brady & Allen, 2006), (Brue, 2002), (Brun, 2011), (Chakrabarty & Chuan, 2006), (Coronado Banuelas & Antony, 2002), (Cronemyr, 2007), (Firka, 2010), (Goldstein, 2001), (Hahn, 2005), (Henderson & Evans, 2000), (Hilton, et al., 2008), (Johnson & Swisher, 2003), (Kim, 2010), (Kumar & Antony, 2008), (Kumar, et al., 2009), (Kwak & Anbari, 2006), (Leong & Teh, 2012), (Pfeifer, et al., 2004), (Schroeder, et al., 2008), (Szeto & Tsang, 2005), (Timans, et al., 2012)	25	61
Linking Six Sigma to Business Strategy	(Aboelmaged, 2010), (Antony & Banuelas, 2002), (Antony & Desai, 2009), (Antony, et al., 2007), (Brady & Allen, 2006), (Brun, 2011), (Caldwell, et al., 2009), (Chakrabarty & Chuan, 2006), (Coronado Banuelas & Antony, 2002), (Firka, 2010), (Goh, 2002), (Hahn, 2005), (Hilton, et al., 2008), (Johnson & Swisher, 2003), (Khadiri, et al., 2014), (Kumar & Antony, 2008), (Kumar, et al., 2009), (Laureani & Antony, 2012), (Pfeifer, et al., 2004), (Pulakanam & Voges, 2010), (Salaheldin & Abdelwahab, 2009), (Snee & Hoerl, 2003), (Szeto & Tsang, 2005), (Timans, et al., 2012)	24	59

Success factor	Reference	Total	
		n	%
Organizational Infrastructure	(Aboelmaged, 2010), (Antony & Banuelas, 2002), (Antony & Desai, 2009), (Antony, et al., 2007), (Brue, 2002), (Brun, 2011), (Caldwell, et al., 2009), (Coronado Banuelas & Antony, 2002), (Cronemyr, 2007), (Firka, 2010), (Hahn, 2005), (Henderson & Evans, 2000), (Hilton, et al., 2008), (Johnson & Swisher, 2003), (Khadiri, et al., 2014), (Kim, 2010), (Kumar & Antony, 2008), (Kumar, et al., 2009), (Kwak & Anbari, 2006), (Leong & Teh, 2012), (Pfeifer, et al., 2004), (Pulakanam & Voges, 2010), (Szeto & Tsang, 2005), (Timans, et al., 2012)	24	59
Project Prioritization and Selection, Reviews and Tracking	(Aboelmaged, 2010), (Anand, 2008), (Antony & Banuelas, 2002), (Antony & Desai, 2009), (Antony, et al., 2007), (Brady & Allen, 2006), (Brue, 2002), (Brun, 2011), (Caldwell, et al., 2009), (Coronado Banuelas & Antony, 2002), (Cronemyr, 2007), (Firka, 2010), (Goldstein, 2001), (Hahn, 2005), (Hilton, et al., 2008), (Johnson & Swisher, 2003), (Kim, 2010), (Kumar & Antony, 2008), (Kumar, et al., 2009), (Kwak & Anbari, 2006), (Pfeifer, et al., 2004), (Snee & Hoerl, 2003), (Szeto & Tsang, 2005), (Timans, et al., 2012)	24	59
Linking Six Sigma to the Customer	(Aboelmaged, 2010), (Antony & Banuelas, 2002), (Antony & Desai, 2009), (Antony, et al., 2007), (Brady & Allen, 2006), (Brun, 2011), (Coronado Banuelas & Antony, 2002), (Firka, 2010), (Goh, 2002), (Goldstein, 2001), (Hahn, 2005), (Khadiri, et al., 2014), (Kumar & Antony, 2008), (Kumar, et al., 2009), (Martens, 2001), (Pfeifer, et al., 2004), (Pulakanam & Voges, 2010), (Schroeder, et al., 2008), (Timans, et al., 2012), (Zu, et al., 2006)	20	49
Understanding the Six Sigma Methodology, Tools, and Techniques	(Aboelmaged, 2010), (Anand, 2008), (Antony & Banuelas, 2002), (Antony & Desai, 2009), (Antony, et al., 2007), (Brun, 2011), (Caldwell, et al., 2009), (Coronado Banuelas & Antony, 2002), (Cronemyr, 2007), (Firka, 2010), (Goh, 2002), (Hahn, 2005), (Henderson & Evans, 2000), (Kumar & Antony, 2008), (Magnusson, et al., 2003), (Schroeder, et al., 2008), (Szeto & Tsang, 2005), (Timans, et al., 2012), (Zu, et al., 2006)	19	46

Success factor	Reference	Total	
		n	%
Cultural Change	(Aboelmaged, 2010), (Anand, 2008), (Antony & Banuelas, 2002), (Antony & Desai, 2009), (Antony, et al., 2007), (Brun, 2011), (Chakrabarty & Chuan, 2006), (Coronado Banuelas & Antony, 2002), (Firka, 2010), (Hilton, et al., 2008), (Kumar & Antony, 2008), (Kumar, et al., 2009), (Kwak & Anbari, 2006), (Laureani & Antony, 2012), (Leong & Teh, 2012), (Rajamanoharan & Collier, 2006), (Szeto & Tsang, 2005), (Timans, et al., 2012)	18	44
Project Management Skills	(Antony & Banuelas, 2002), (Antony & Desai, 2009), (Antony, et al., 2007), (Brady & Allen, 2006), (Brue, 2002), (Brun, 2011), (Coronado Banuelas & Antony, 2002), (Firka, 2010), (Hilton, et al., 2008), (Kumar & Antony, 2008), (Kumar, et al., 2009), (Kwak & Anbari, 2006), (Pfeifer, et al., 2004), (Pulakanam & Voges, 2010), (Snee & Hoerl, 2003), (Szeto & Tsang, 2005), (Timans, et al., 2012)	17	41
Communication	(Aboelmaged, 2010), (Anand, 2008), (Brue, 2002), (Brun, 2011), (Coronado Banuelas & Antony, 2002), (Firka, 2010), (Goldstein, 2001), (Henderson & Evans, 2000), (Hilton, et al., 2008), (Kumar & Antony, 2008), (Kumar, et al., 2009), (Schroeder, et al., 2008), (Timans, et al., 2012)	13	32
Linking Six Sigma to Suppliers	(Aboelmaged, 2010), (Antony & Banuelas, 2002), (Antony & Desai, 2009), (Brun, 2011), (Coronado Banuelas & Antony, 2002), (Firka, 2010), (Goldstein, 2001), (Kumar & Antony, 2008), (Kumar, et al., 2009), (Schroeder, et al., 2008), (Timans, et al., 2012), (Zu, et al., 2006)	12	29

Distribution of Six Sigma Critical Success Factors

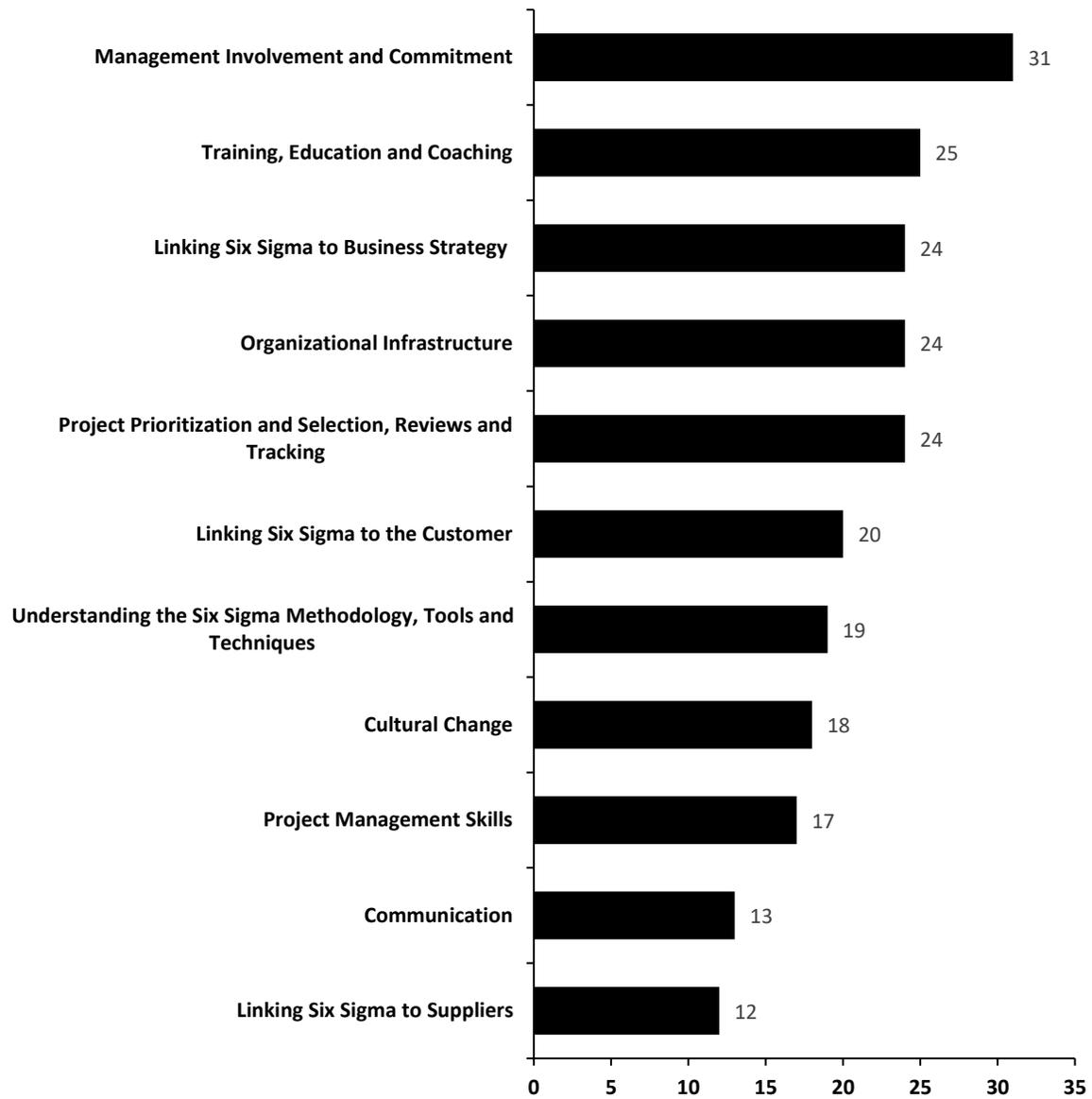


Figure 2. Bar chart showing the distribution of each CSF identified in the literature study.

3.2.1 Management Involvement and Commitment

The most frequently mentioned critical success factor in the literature is having the management involved and committed to Six Sigma, see Table 3. This being the most important critical success factor is agreed upon by those who use Six Sigma in their organizations (Henderson & Evans, 2000). To ensure the management is involved in the Six Sigma efforts they need to be taught the fundamental principles of Six Sigma (Antony & Banuelas, 2002; Magnusson, et al., 2003). Magnusson et al., (2003) suggest that senior management should undergo a course that focuses on what Six Sigma is, how Six Sigma should be introduced in the organization and the importance of senior management commitment. Furthermore, the authors describe that the training usually lasts for one or two days. The top management's support is vital to make the necessary restructuring and to change the culture within the organization (Henderson & Evans, 2000). Having the top management involved in Six Sigma also enables clear goals and communication to all employees (Goldstein, 2001). Magnusson et al. (2003) identified that to be successful in Six Sigma the top management needs to determine the scope and be long-term committed to the cause.

Another way of keeping the management involved and committed to Six Sigma is by having regular occurring meetings which the management team attends (Cronemyr, 2007). The author provides examples of how many meetings there could be, who should attend them, what should be discussed, and how these meetings are connected, see Figure 3.

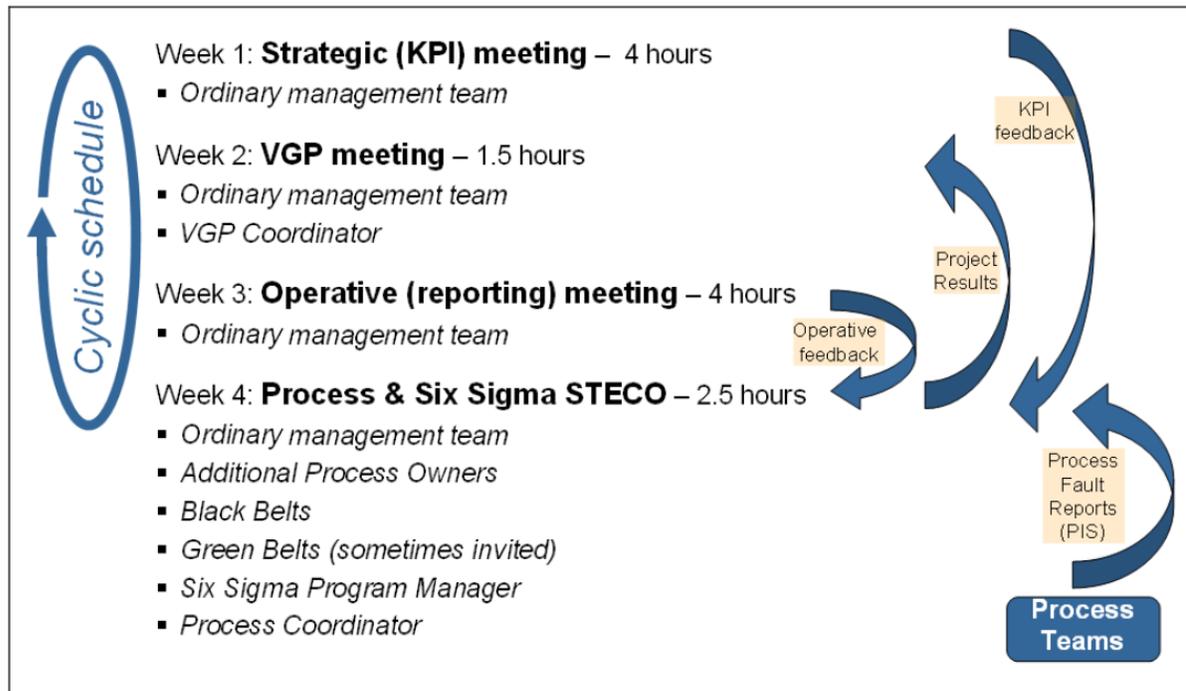


Figure 3. Simplified version of the different meetings Siemens had for Six Sigma. Based on (Cronemyr, 2007, p. 63).

The first meeting is a Strategic Key Performance Index (KPI) Meeting that focuses on KPI's where possible Six Sigma projects are identified by analyzing the KPI's current performance (Cronemyr, 2007). A week after that, a meeting for following up the results from previous Six Sigma projects are held, the Value Generation Program (VGP) Meeting. This meeting is followed by an Operative (Reporting) Meeting where a progress report is provided by every department manager. Lastly, the Process & Six Sigma Steering Committee (STECO) meeting is held focusing on Six Sigma project progress and new project ideas. The meetings are cycled through every four weeks.

3.2.2 Training, Education, and Coaching

Training the employees in Six Sigma practices is another cornerstone of a successful implementation (Henderson & Evans, 2000). The key is the quality of the training and not just the number of employees involved in the training program (Goldstein, 2001). Brue (2002) suggests starting the training at the top with the executives and managers, with the goal of increasing the knowledge to successfully operate Six Sigma projects. The Black Belt training can successfully combine theoretical education with practical work in real projects (Sörqvist & Höglund, 2017). By using real projects from the organization, the employees will get more involved and have an easier time relating to the project.

Magnusson, et al., (2003) claim that companies take the education program very seriously. The authors cite Motorola as an example as they invested USD 50 million annually in Six Sigma from 1987 to 1992. They further describe that this represented 40 percent of the total education budget at the company. Motorola estimated that they saved USD 2.4 billion from the Six Sigma program during the same period which gave Motorola an investment ratio of 29: 1.

3.2.3 Linking Six Sigma to Business Strategy

For the Six Sigma initiative to be successful, it must be connected to the business strategy (Antony & Banuelas, 2002). The goals of every Six Sigma project should align with the overall goals of the organization (Magnusson, et al., 2003). This alignment cannot be achieved by only using the tools and techniques of the Six Sigma methodology. Firka (2010) gives one example of a company that had a strong connection between the Six Sigma projects and the business strategy. The company used a top-down approach of using scorecards to identify which areas the potential Six Sigma projects could focus on. Another way of linking Six Sigma to business strategy is by having strategic meetings to identify the areas that are currently underperforming and find potential Six Sigma projects in the areas identified (Cronemyr, 2007).

3.2.4 Organizational Infrastructure

How the organization is structured for Six Sigma is a frequently occurring critical success factor. The importance of the top management involved and committed has already been explained, but it is also important that employees at all levels are committed to the cause (Henderson & Evans, 2000). The authors further explain that every team member's role and responsibilities must be defined and specified, and it is important to communicate exactly what is expected from the specific roles. Furthermore, a well-defined and clear organizational infrastructure is therefore needed to help clarify this.

Henderson & Evans (2000) also point out that the role a project participant is having is depending on their tasks and training level. Those roles are usually Champion/Sponsor, Master Black Belt, Black Belt, Green Belt, and White/Yellow Belt, which is further described in chapter 3.4.

According to Sörqvist & Höglund (2017), improvement work has traditionally been conducted on an ad hoc basis, which means that planning and organization are determined specifically for each individual situation based on the current conditions. The authors further claim that this approach is slow and cumbersome. Sörqvist & Höglund (2017) believe that the establishment of a clear organization to drive improvements from the outside and that the necessary resources and skills are available is important for an organization to succeed in its improvement work. The act of achieving this is further referred to as the establishment of an infrastructure for improvement work.

3.2.5 Project Prioritization and Selection, Reviews and Tracking

Not every improvement project is suited for the Six Sigma methodology. Selecting the right project is important to enabling Six Sigma initiative being successful (Goldstein, 2001). The author claims that the aspects to take into consideration when selecting a Six Sigma project are: the financial benefit, if data can be easily collected, if the project has a high probability of success, and if it can be completed within the given timeframe.

Sörqvist & Höglund (2017) claims that an organization that works ambitiously with an improvement program such as Six Sigma should establish a systematic methodology for identifying and choosing which improvement projects to carry out. Figure 4 below is retrieved from Sörqvist & Höglund (2017) and shows an example of how such a process can be designed. The process demonstrates how the company Swedish ball bearing company (SKF) selects projects in a standardized way.

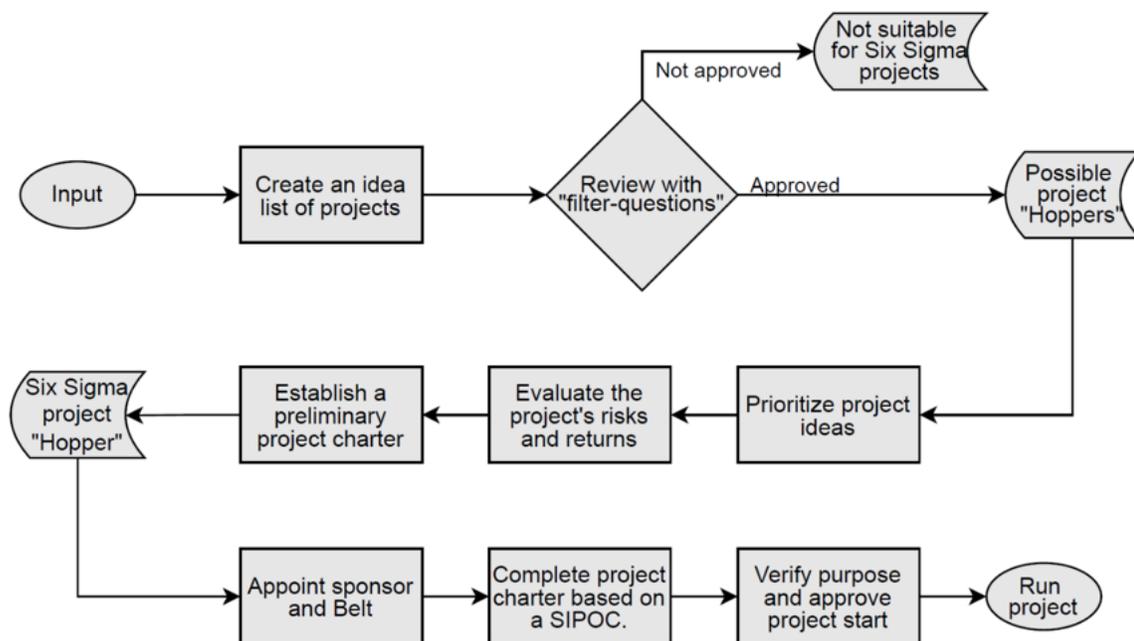


Figure 4. SKF's process for identifying and selecting Six Sigma projects. Based on (Sörqvist & Höglund, 2017, p. 122).

The process at SKF (Figure 4) includes a step called "review with filter questions". This step intends to make an initial selection of which projects are suitable to proceed as possible Six Sigma projects. The selection was done at SKF with help of the filter questions found in Figure 5 below.

<u>FILTER QUESTIONS</u>	
Is the solution known?	No – Six Sigma project Yes – Implement the solution
Is there enough data available to quantify the problem?	No – Develop a measurement plan Yes – Six Sigma project
Is the root cause known with certainty?	No – Six Sigma project Yes – Implement known solution
Is the problem solved somewhere else?	No – Six Sigma project Yes – Implement the solution of the previous project
Does the project affect a strategic focus area?	No – Not a Six Sigma project Yes – Six Sigma project
Does the project's result/return meet set goals?	No – Stop the project Yes – Six Sigma project
Does the project apply to a new product, service or process?	No – Use DMAIC Nej – Use DFSS

Figure 5. SKF's filter questions for selection of suitable Six Sigma projects. Based on (Sörqvist & Höglund, 2017, p. 122).

The process at SKF contains another step that requires a more detailed explanation. The step is called "Prioritize project ideas" in the process (see Figure 4). Sörqvist & Höglund (2017) claims that one of the most crucial factors in achieving success with the improvement work is to prioritize the projects that add the greatest benefit and value to the business. They further believe that this is both complex and difficult and consists of strategic and tactical factors. The authors describe strategic factors as factors that can affect the results and success of the business. For example, financial savings opportunities, the impact on customer satisfaction and increased efficiency. Tactical factors are instead described as factors that have to do with the suitability to implement a certain improvement. For example, this may include simplicity to carry out the project, if it can achieve quick results and the employees' attitude towards the project.

Sörqvist & Höglund (2017) suggests that an organization should use a prioritization matrix to prioritize projects in the right way. Figure 6 below shows the example they give of how a prioritization matrix can be designed. However, the authors are careful to emphasize that the final prioritization decision is always a compromise between strategic and tactical factors.

They claim that the prioritization in most cases is not a decision based on absolute facts about the various alternatives, but a relative comparison between these.

	Cost	Financial savings	Customer effect	Difficulty	Spreadability	
Weight	8	10	6	6	4	TOTAL
Project 1	6	8	1	2	0	146
Project 2	10	2	0	6	6	160
Project 3	0	10	1	2	3	130
Project 4	4	6	5	8	9	206
Project 5	3	5	10	10	8	226

Figure 6. Prioritization matrix for choosing between different possible improvement projects. Based on (Sörqvist & Höglund, 2017, p. 121).

Cronemyr (2021) suggests that projects should be selected based on the potential improvement effect and the effort/complexity of the projects. Figure 7 describes which projects, according to Cronemyr that are suitable for the Six Sigma methodology based on their effect and complexity. He states that potential projects found in the upper right corner of the rectangle are suitable for the Six Sigma methodology. These projects have medium to high complexity and high improvement effect. In the lower right corner of the rectangle are the projects that may be suitable for the Six Sigma methodology at a later time. These projects currently do not have a sufficient improvement effect and need time for collecting more facts. Projects found on the left in Figure 7 are not suitable for the Six Sigma methodology and should be solved using continuous improvement/Lean tools or the "Just Do It" method.

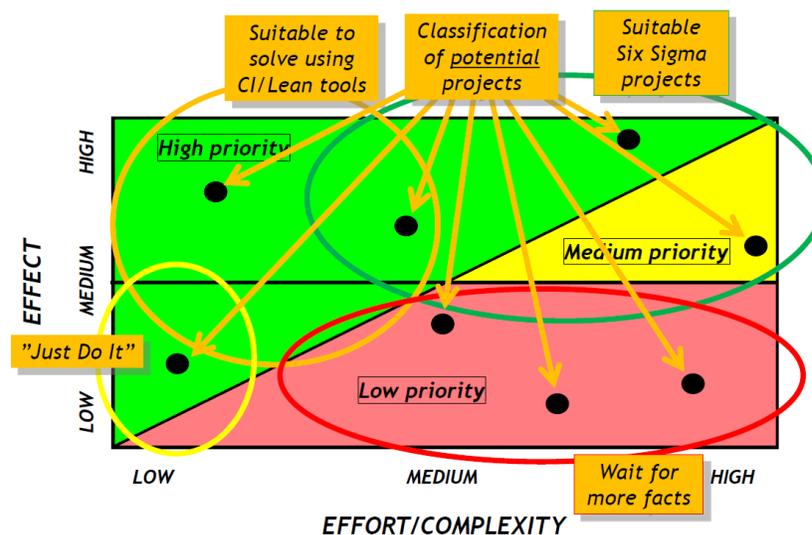


Figure 7. Effort-Effect diagram. Retrieved from (Cronemyr, 2021, p. 37).

Just as project selection is an important factor, project reviews are equally important. By having regularly scheduled project reviews, the progress of the projects can be easily tracked (Antony & Banuelas, 2002). By having the scheduled reviews, the possible barriers that hinder the project's progress can be highlighted and addressed. Cronemyr (2007) provides an example of how often the scheduled progress meetings could take place and in which forums projects can be prioritized and selected (see Figure 3). For the Six Sigma progress meetings the author also provided the meeting agenda that can be seen in Figure 8 below.

Typical Agenda	Who
<i>Six Sigma STECO:</i>	
Six Sigma status in <i>sigma+</i>	SSPM
Black Belt Project Status Reports	BB:s/PO:s
Green Belt Project Status Reports	PO:s/(GB:s)
New Project Ideas	All
<i>Process STECO:</i>	
Reports from Process Teams (all processes)	PO:s
Other and Follow-up on last MoM	All
+ and Δ (Feed-back of the meeting)	All
SSPM = Six Sigma Program Manager PO = Process Owner BB = Black Belt GB = Green Belt	

Figure 8. Agenda for the Process & Six Sigma Steering Committee meeting at Siemens. Retrieved from (Cronemyr, 2007, p. A:29).

3.2.6 Linking Six Sigma to the Customer

Having a customer focus in the Six Sigma initiative goes hand-in-hand with linking Six Sigma to the business strategy (Goldstein, 2001). The author points out that all organizations operate from the premise of meeting their customer's needs. By aligning the projects with the customer needs, benefits such as increased sales will also follow.

Antony, et al., (2007), states that the Six Sigma strategy is used in service processes to understand how defects occur and then apply process improvements to reduce the occurrence of these. Furthermore, the process improvements should be implemented with the goal of improving the overall customer experience and thereby increasing customer satisfaction. Cho, et al., (2011), on the other hand, highlights a clear customer focus as fundamental in the improvement work to achieve maximum effects when implementing Six Sigma.

Linderman, et al., (2003), states that a key step for a successful Six Sigma implementation is to determine exactly what the customer requires and from this define defects in terms of their critical to quality parameters. The author also highlights that Six Sigma, from an objective perspective, advocates establishing goals based on the customer's requirements, not based on internal considerations.

3.2.7 Understanding the Six Sigma Methodology, Tools, and Techniques

In Six Sigma training, the employees will learn about three types of tools: statistical, process, and team tools (Henderson & Evans, 2000). The authors explain that by training the employees in Six Sigma methodology and the tools, their understanding of how to operate in a Six Sigma project will increase. The authors further explain that the process and team tools are focusing on the leader and the project management part, while the statistical tools are used to identify variation and control the process. It is equally important to understand the DMAIC cycle, as well as what tools and techniques that are used in each phase (Antony & Banuelas, 2002). By understanding the tools that are in hand and when they are to be used, they can efficiently be put into practice (Hahn, 2005).

3.2.8 Cultural Change

For the Six Sigma initiative to be successful, employees need to be committed to the new method. To achieve this, the culture of the organization must change, and the employees need to be motivated and want to improve the quality of their work (Antony & Banuelas, 2002). Motivation is needed on all levels of the organization. A good way of stressing the importance of needing to change is to increase communication, motivation, and education (Antony & Banuelas, 2002). Cultural change does not necessarily come by just implementing Six Sigma. However, if the organization stays committed to the methodology and integrates its concepts into the organization, cultural change can grow as the knowledge and experience of working with Six Sigma grows (Firka, 2010).

3.2.9 Project Management Skills

While the tools and techniques used in Six Sigma are important for its success, having the right project managers, or Black Belt, is also vital. Key characteristics to have as a Black Belt include leadership, technical skills, statistical knowledge, good at communicating and motivating (Brue, 2015). If a Six Sigma project fails it is usually due to a lack of project management skills (Antony & Banuelas, 2002). In an article by Pulakanam & Voges (2010), the authors analyzed four different studies that examined CSF within Six Sigma. In the studies, they were able to identify project management skills as one of the five most important factors in all four.

3.2.10 Communication

Spreading the word of Six Sigma in the organization is important. Communicating both before implementing and continuously throughout the implementation helps get the employees involved (Goldstein, 2001). Getting the word out before the start of the implementation can be used to see employee's initial reactions and from that adjust the implementation strategy if needed (Anand, 2008). A barrier to implementing Six Sigma among the employees is fear of change and fear of not living up to the new standards (Henderson & Evans, 2000). The initial communication plan should focus on addressing these two fears. A suggestion of how a communication plan could be structured and what to include in it is seen in Table 4.

Table 4. Communication plan. Based on (Pyzdek & Keller, 2010, chpt.1.2).

Requirement	Method	Frequency	Accountability
Senior Leadership			
Program strategy, goals, and high-level program plan	<ul style="list-style-type: none"> • Senior staff meeting • Senior leadership training 	<ul style="list-style-type: none"> • At least monthly • Start of program 	<ul style="list-style-type: none"> • CEOs • Six Sigma Director • Training department
Metrics/status performance to program plan	<ul style="list-style-type: none"> • Senior staff meetings 	<ul style="list-style-type: none"> • At least monthly 	<ul style="list-style-type: none"> • Six Sigma Director
Middle Management			
Program strategy, goals, and management-level program plan	<ul style="list-style-type: none"> • Regular flow down of upper-level staff meeting notes; newsletter • Management training 	<ul style="list-style-type: none"> • At least monthly for staff meetings; newsletter piece every two weeks during program rollout, as needed thereafter • Prior to first wave of Six Sigma projects 	<ul style="list-style-type: none"> • Senior Leadership for staff meeting flow down • Internal communications via core team for company newsletter • Training department
Etc. for customers, owners, suppliers, exempt employees, or other stakeholder group			

3.2.11 Linking Six Sigma to Suppliers

It has been found that linking Six Sigma to other parties in the supply chain can be beneficial (Antony & Banuelas, 2002). The same most important critical success factor applies when integrating the suppliers to Six Sigma, the top management's support at the supplier. Even if the suppliers cannot be integrated fully, they can still assist in some parts of the Six Sigma projects (Firka, 2010).

3.3 Implementing Six Sigma

Six Sigma is not a magic pill that solves problems automatically by filling in some blank fields in a computer program. It requires people who are good thinkers with strong analytical skills and high creative ability (Goldstein, 2001). When adding employees to a Six Sigma program, it is advantageous to choose people who want to be part of the program. If possible, an atmosphere where staff is selected through pull rather than push is preferable. This means that the staff that is a part of the Six Sigma program should be that because they were attracted by the opportunity rather than being forced to be a part of the program (Goldstein, 2001).

The basic steps when implementing Six Sigma are similar for all companies (Magnusson, et al., 2003). The only thing that differentiates is how the steps should be implemented. The implementation procedure differs between the companies because of the unique culture of each company. What works in one company may not work in another (Anand, 2008).

Pyzdek & Keller (2010) and Magnusson et. al., (2003) each present an implementation plan for Six Sigma. Both plans break down the Six Sigma implementation process into smaller steps to clarify what is needed for an implementation to be successful. The two implementation plans are presented in Figure 9 and Figure 10.

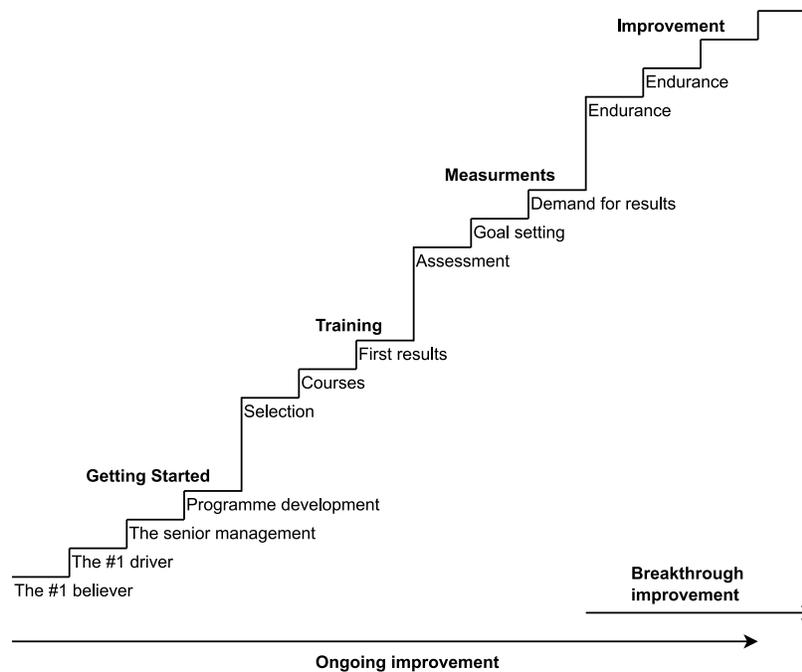


Figure 9. Implementation plan for Six Sigma divided in 12 steps. Based on (Magnusson, et al., 2003, p. 81).

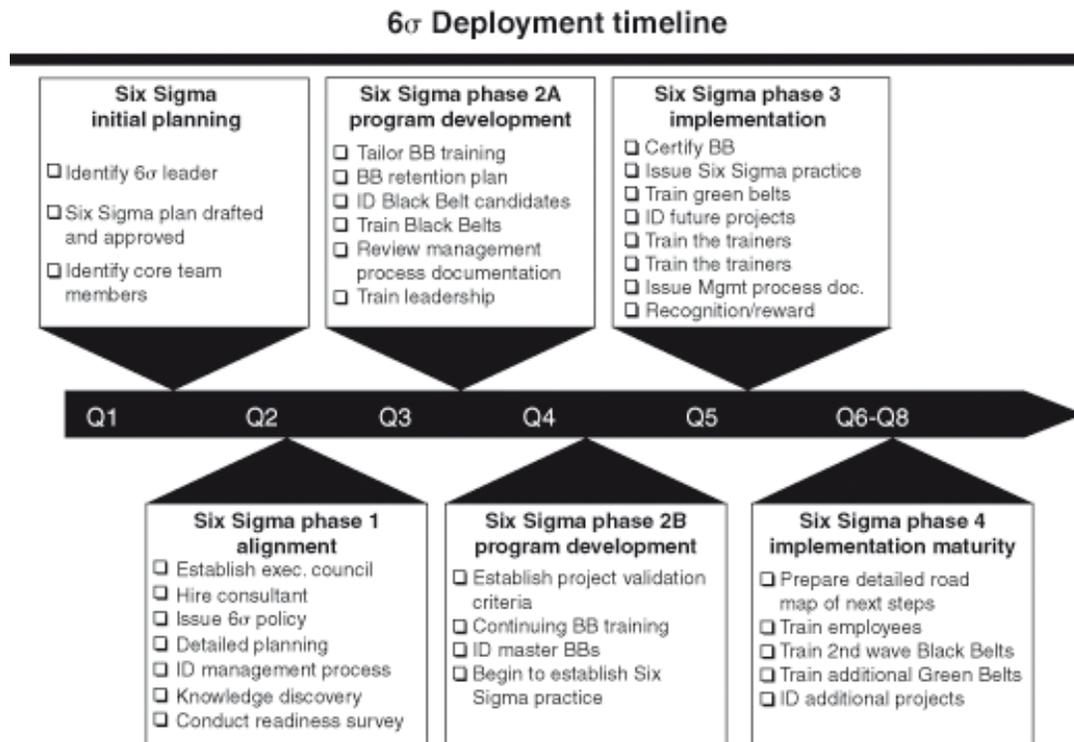


Figure 10. An example of typically used activities and timeline when implementing Six Sigma. Retrieved from (Pyzdek & Keller, 2010, chpt. 1.2).

3.3.1 Implementing Six Sigma Within a Healthcare Context

Even though Six Sigma is more widely used in an industrial context, several cases from around the world prove that Six Sigma can be used in a healthcare context as well (Bisgaard, 2009, p. XIV). Cases from the Netherlands (van den Heuvel, et al., 2005) and Sweden (Lifvergren, et al., 2010) show that the Six Sigma methodology can be adapted into the healthcare context and be a successful tool to reduce costs and, perhaps more importantly, increase the patient safety and satisfaction. The implementation of Six Sigma does not come easily though. Since the methodology is developed within an industrial context, to make it fit healthcare, some adjustments to the methodology must be done.

Caldwell et al. (2009) describes successfully deploying Six Sigma in healthcare as reaching the Magic Moment. The steps included in the Magic Moment align with previously identified CSFs in Six Sigma. The step describes the need of connecting the goals of Six Sigma with the strategic business goals, selecting projects that help achieving those goals, the involvement and commitment of leaders, developing an infrastructure surrounding Six Sigma, and progress monitoring. Both the managers and the employees being motivated and committed to Six Sigma is reoccurring success factors in healthcare-related literature (Barry, et al., 2002; Bisgaard, 2009). In addition to securing the commitment from employees and managers, Bisgaard (2009) also presses the importance of managing the overall Six Sigma effort. This includes project selection, having a concrete deployment plan, committing the resources necessary, and regular project reviews.

Having a deployment plan is a key factor that is mentioned by other authors as well (Mount, et al., 2012). Furthermore, the way to introduce Six Sigma to a healthcare organization is best achieved by starting small at a few units (Arthur, 2016). A key point here is to create projects that target problems that are well-known and has a high probability of success. After the first projects have proven to be successful, Six Sigma can start expanding to more units within the organization. It is also important to let the teams working on Six Sigma projects learn by doing while strictly following the DMAIC cycle (Bisgaard, 2009). The data-driven approach and it being the basis of decisions, helps overcome employees' reluctance to change and will enable a changing culture in the organization.

3.4 Six Sigma infrastructure and roles

Within Six Sigma, the executive management plays a crucial role in creating the conditions for a successful Six Sigma culture and an indirect role in the tactical part of Six Sigma. However, the direct roles and responsibilities of the Six Sigma teams are equally important (Eckes, 2003). Taylor (2009) highlights that Six Sigma project teams authorized by the management, are the basic building blocks in the successful implementation of Six Sigma. The project team's primary task is to solve specific problems and implement improvements in the organization's operations. They are also the main ingredient for an organization to successfully eliminate the obstacles that exist to achieve maximum productivity.

Truscott (2003) highlights that an ultimate mix of different personalities, behavioral styles, and work styles are important components for successful teamwork (Truscott, 2003). Brue (2015) claim that appropriate operational and technical skills in successful teamwork are often obvious. He further highlights that requirement for balance between different behavioral styles is not as obvious but still important. Regardless of the role within the Six Sigma work, each participant must take full responsibility for a specific area (Brue, 2015). The author further claims that in short, being responsible means being dependable, accountable, and trustworthy.

To manage and support various activities associated with the implementation of Six Sigma an organizational infrastructure is required (Pyzdek & Keller, 2010). A transformation process in the implementation of Six Sigma involves new areas of responsibility and roles for many individuals within the organization (Pyzdek & Keller, 2010). Truscott (2003) claims that one of the most important steps when implementing Six Sigma in an organization is to define appropriate roles and their areas of responsibility. The author further emphasizes that the definition of the roles should be based on several factors such as the organization's Six Sigma goals, implementation plan, budget, and existing resources. Knapp (2015) emphasizes that a key component of Six Sigma is the unique infrastructure that uses various predefined roles.

According to Barry, et al., (2002) trained Six Sigma personnel often referred to as Green Belts in cases where they are qualified to carry out projects and Black Belts when they are qualified to design projects. They further describe that the highest rank is Master Black Belt who is qualified to teach Six Sigma to others and to direct multiple projects under management direction.

Barry, et al., (2002) also highlights that some large companies that have been successful in their Six Sigma work require that all management candidates have an education to at least the Six Sigma Green Belt level. However, this is not necessary to start the implementation of Six Sigma, as only a small core of Six Sigma personnel is required (Barry, et al., 2002). Barry, et al., (2002) further emphasizes that organizations usually choose to train a small number of their employees to apply Six Sigma as this is considered more economical than hiring long-term consultants.

The exact definition of the different roles differs in the literature. The roles that are mentioned most frequently in the literature are Champion/Sponsor, Master Black Belt (MBB), Black Belt (BB), Green Belt (GB), Yellow Belt (YB), and White Belt (WB) (see Table 5).

Table 5. Six Sigma roles listed in the literature.

Author's proposition of Six Sigma Roles	Reference
Champion/Sponsor	(Brue, 2002), (Eckes, 2001), (Kubiak, 2014), (Magnusson, et al., 2003), (Mashinini-Dlamini & van Waveren, 2013), (Pande, et al., 2014), (Pyzdek & Keller, 2010)
Master Black Belt, Black Belt and Green Belt	(Brenig-Jones & Dowdall, 2018), (Brue, 2002), (Brue, 2015), (Eckes, 2001), (Kubiak, 2014), (Magnusson, et al., 2003), (Mashinini-Dlamini & van Waveren, 2013), (Pande, et al., 2014), (Magnusson, et al., 2003), (Pyzdek & Keller, 2010), (Stankalla, et al., 2019), (Sörqvist & Höglund, 2017), (Taghizadegan, 2013), (Taylor, 2009), (Voehl & Harrington, 2014)
Yellow Belt	(Brenig-Jones & Dowdall, 2018), (Kiran, 2017), (Mashinini-Dlamini & van Waveren, 2013), (Pande, et al., 2014), (Stankalla, et al., 2019), (Sörqvist & Höglund, 2017), (Taylor, 2009), (Voehl & Harrington, 2014)
White Belt	(Brenig-Jones & Dowdall, 2018), (Magnusson, et al., 2003), (Sörqvist & Höglund, 2017)

3.4.1 Champion/Sponsor

Champion is a Senior Manager, crucial to avoiding failures and achieving success in all Six Sigma projects and are ultimately responsible for project results (Brue, 2002). The author further claim that champions have an overall responsibility to ensure that resources are available for Six Sigma training and process improvement projects. He also emphasizes that champions can and should use their authority to overcome organizational barriers. Pyzdek & Keller (2010), Mashinini-Dlamini & van Waveren (2013), and Kubiak (2014) claim that a

champion is a high-level individual; usually an senior manager, who understands Six Sigma and is committed to its success

Some of the champion's main responsibilities that Pande, et al., (2002) highlights are:

- Establish a logic and a goal for business improvements.
- Be open to changes in the project definition and scope as the team collects data and deepens its analysis of the process.
- If necessary, support and approve changes to the team's charter and project scope
- Ensure available resources such as time, support, and money for the team.
- Advocating for the team's efforts to the Leadership Council.
- Deal with ongoing disruptions that arise for the team when they encounter bureaucratic roadblocks.
- Collaborate with other managers to ensure smooth delivery of the team's solutions.
- To understand and absorb the importance of data-driven management from the team and apply the lessons learned to their managerial job.

Sörqvist & Höglund (2017) emphasizes that the training to become a Sponsor can vary somewhat in structure and content. They claim that a common design of the training is a two-day workshop. Furthermore, they describe that the training aims to give the people who have been appointed Sponsors an understanding of Six Sigma and how they should act as Sponsors in the improvement work.

Kubiak (2014) asserts that some writers make a distinction between a sponsor and a champion. The writers claim that a sponsor is a manager who takes on the roles and responsibilities associated with executive management. As a large part of the authors believe that the two roles are the same, the champion and sponsor have been placed under the same heading in this work.

3.4.2 Master Black Belt

Brue (2015) claim that the Master Black Belt is an expert on Six Sigma tools and tactics. He further highlights that the person is a resource that is valuable in terms of historical and technical expertise. The author also emphasizes that The Master Black Belt ensures that the necessary infrastructure is in place and that black belts are trained. A Master Black Belt can be said to be a teacher, mentor, leading change agent, and focuses 100% on process improvements (Brue, 2015).

According to Pyzdek & Keller (2010), the role of Master Black Belt is the highest level in terms of organizational and technical skills. The role includes responsibility for providing technical leadership and coaching for the Six Sigma program and is usually a full-time job (Kubiak, 2014; Pyzdek & Keller, 2010). A Master Black Belt must be well versed in the knowledge that a Black Belt possesses (Pyzdek & Keller, 2010). In addition to this, the person should possess additional skills including the mathematical theory that underlies the statistical methods, coaching, project management, teaching, and program organization at the company level. An important task in the work as a Master Black Belt is to help Black Belts to apply the Six Sigma methods correctly in unusual situations (Taylor, 2009; Pyzdek & Keller, 2010). If

possible, Master Black Belts or equivalently skilled consultants should be solely responsible for training Black Belts and Green Belts (Pyzdek & Keller, 2010). Pyzdek & Keller (2010) further describes that if this is not followed, the well-known phenomenon of "propagation of error" will occur within the organization. The phenomenon implies that Black Belt trainers spread the wrong information to the Black Belt trainees, who then spread the wrong information to the Green Belts, who spread even greater errors to the team members.

Voehl & Harrington (2014) claims that the standard practice for an organization is one Master Black Belt for every 15-20 Black Belts. They further claim that cases where the organization has less than 200 employees, a single Master Black Belt is sufficient for the entire organization. The role should be held by a person who is certified by a Project Management Institute and is a very skilled project manager. Voehl & Harrington (2014), Kubiak (2014), Taylor (2009), and Pande, et al., (2002) mentions, inter alia, that the following parts are a Master Black Belts main responsibility:

- Educate and certify Black Belts and Green Belts
- Act in projects where Black Belts encounter difficulties defining root causes and implementing changes
- Identify and implement long-term Six Sigma projects
- Review and approve projects and project plans created by Black Belts and Green Belts.
- Communicate with leadership council and champions
- Coach – be a contributor to the completion of projects. Promote team improvement by providing feedback, criticizing team effectiveness, and motivating and inspiring the team to succeed with Six Sigma methods
- Act as a barrier breaker – must be able to break barriers for themselves instead of always relying on the champion
- Act as an evangelist – they need to have a strong drive for Six Sigma and spread the word as they within the organization are considered experts. An important task in this is to be out on the firing line and meet and convert the naysayers
- Be a doer – possess the ability to carry out projects from start to finish despite any setbacks

Voehl & Harrington (2014) highlights that when an organization implements Six Sigma for the first time, they usually lack people with enough experience to assume the role of Master Black Belt. They further write that even if an employee undergoes training for the Black Belt and Master Black Belt, they do not have the necessary experience required for successful leadership. The authors further claim that as a result, organizations normally hire a consultant who acts as a Master Black Belt for the first 6-12 months. Thereafter, one or more Black Belts are selected from the organization who may undergo further training to be a Master Black Belt

3.4.3 Black Belt

Voehl & Harrington (2014) believes that Black Belts are skilled individuals and effective problem solvers who have a good understanding of the statistical tools required to work in accordance with the Six Sigma method. The authors further claims that Black Belt's responsibility is to lead the Six Sigma Team and to develop the right people to run Six Sigma

projects. Voehl & Harrington (2014) also highlights that the persons recruited into the role should be experienced professionals who are highly respected throughout the organization. Hoerl (2001) describes Black Belts as the technical backbone of achieving a successful Six Sigma initiative and claims that they are the individuals who generate the actual savings. He also claims that the Black Belt should have the ability to apply statistical tools with the aim of solving real problems. Other abilities mentioned are organizational efficiency abilities such as project and team leadership and skills in meeting management.

Pyzdek & Keller (2010) claims that people who work as Black Belts should be technically oriented individuals who are highly regarded by their peers. They further highlight that Black Belts must actively participate in processes related to organizational development and change. The authors also describes that the suitable candidates do not have to be formally trained statisticians or analysts and can be recruited from a wide range of disciplines. However, Black Belts are expected to master many different technical tools in a relatively short time, which means that they probably have a background in mathematics at the university level. Pyzdek & Keller (2010) also emphasized that a strong plus or even a prerequisite for successful work is if the person recruited for the role has read courses in statistical methods. The authors further claims that a Black Belt should receive 3-6 weeks of training in Six Sigma's technical tools. Magnusson et al., (2003), on the other hand, believe that the training program for the Black Belt should be around 6 months with 13 to 17 days of seminars. The authors further emphasized that those who are part of the training program should carry out improvement projects between the seminars. Sörqvist & Höglund (2017) describe details about how the education around Black Belts should be structured. The authors claim that the training should consist of a 20-day theoretical training part broken down into 4-8 blocks. They also emphasized that the theoretical part of the training should be carried out in parallel with the Six Sigma methodology being applied in sharp projects selected from their own organization.

Magnusson, et al., (2003) highlights that most companies include real improvement projects in their training of Black Belts and Green Belts. The authors further describe that Black Belts usually need to complete four in-course improvement projects with the final project generating at least USD 50 000 in savings. They also believe that the goal of this approach is to ensure that the participants have understood the training and can use what they have learned to start generating cost savings at the company.

Magnusson, et al., (2003) also state that most companies, including consulting organizations, that offer these courses usually provide course participants with a certificate when the course is completed.

Voehl & Harrington (2014) claim that Black Belts should not act as coaches but are rather specialists who solve problems and support Green and Yellow Belts. The authors further describe that Black Belts act as leaders and managers for simple, complex, and important projects. Black Belts can be said to be internal instructors and consultants typically assigned full-time to train, lead and support the Six Sigma team (Kubiak, 2014; Voehl & Harrington, 2014). Kubiak (2014) argues that Black Belts should be defined as a full-time role. It has been shown that Black Belt as a part-time role has not been successful. On average, a Black Belt should complete at least eight projects per year led by themselves or by the Green Belts that

they support (Voehl & Harrington, 2014). Voehl & Harrington (2014) claims that a Black Belt normally works with two to four Six Sigma teams at a time and distributes his/her time as follows:

- 35% run projects that he/she is commissioned to lead
- 20% support and guide Green Belts in the projects they lead
- 20% teach formally or informally
- 15% complete analytical work
- 10% define new projects

Taylor (2009) deems that a project team leader is a member of an organization's management team or a closely connected technical expert with responsibility for leading a Six Sigma improvement initiative. They further claim that both Black Belts and Green Belts can hold this role depending on the organization's infrastructure. Due to the need for solid knowledge in statistical analysis, the role is nevertheless often filled by a Black Belt. Taylor (2009) and Eckes (2001) claim that the team leader's main responsibilities, inter alia, includes the following parts:

- Prepare, plan, and conduct team meetings with high efficiency
- Lead the team through the defined Six Sigma process (DMAIC)
- Maintain the project schedule and ensure efficient use of resources
- Utilizing Six Sigma tools and methodologies
- Execute and ensure that all action plans and project tasks are completed within the set time frame
- Cultivating and maintaining political and organizational relations in parallel with communicating the team's progress
- Establish and maintain a continuing link to the team sponsor

3.4.4 Green Belt

Pyzdek & Keller (2010) define Green Belts as project managers with the task of forming and facilitating Six Sigma teams and managing the projects from idea-stage to completion. They claim that the training to become a Green Belt consists of a 5-day classroom training that is carried out in connection with Six Sigma projects. Further training of 10 days can sometimes be used to strengthen the knowledge of software through training. The authors also highlight that Training for Green Belt includes quality management tools, project management, problem-solving, quality control tools, and data analysis. Black Belts usually act as a support to the Green Belts in their training, define the projects, and help assist the projects after the training has ended (Pyzdek & Keller, 2010). The authors also claims that champions should be part of the training for Green Belts.

Sörqvist & Höglund (2017) highlight that Green Belt is a local coordinator in improvement projects, which leads to that the meaning of the role varies greatly between different organizations. Furthermore, they describe that the training usually lasts between 5 to 8 days, but that both longer and shorter alternatives occur. They also mention that the distinction between Green Belts and Yellow Belt is diffuse. Magnusson, et al., (2003), on the other hand, claim that the Green Belt training should last for between four to six days. The author also

claim that employees usually need to complete one in-course improvement project with savings of at least USD 5000 to become a certified Green Belt.

Brue (2015) claims that Green Belts work with assisting Black Belts in their area of operation. Green Belts work part-time on projects that are usually carried out in a specific, limited area within their regular job (Voehl & Harrington, 2014; Brue, 2015). Green Belts should be educated in the Six Sigma method with associated tools and have extensive knowledge of processes and products or services (Brue, 2015). It is usually optimal that Green Belts is a very competent professional who has a detailed understanding of the area where the problem is found (Voehl & Harrington, 2014). The Green Belt role is usually dedicated for middle management such as purchasers, planners, engineers, and supervisors (Magnusson, et al., 2003).

Brue (2015) claims that Green Belts is an important resource for Black Belts and that can assist with analyzing or collecting data, run experiments or be helpful in other important project tasks. He further emphasizes that Green Belts possesses sufficient knowledge to be able to share knowledge about the various tools with other employees and change the corporate culture from the ground up.

Green Belts can participate in Six Sigma process improvement projects as team members, alternatively being responsible for leading small projects with a Black Belt as a mentor (Brue, 2015). By collaborating and working complementary with the executive leaders, champions, and Black Belts, Green Belts can be considered "worker bees" who drive results on the bottom line (Brue, 2015).

3.4.5 Yellow Belt

According to Taylor (2009), the project members are the foundation of the project group and are thus incredibly important for the performance improvements in an organization. The author also highlights that the project members are employees with a Six Sigma education corresponding to a Green or Yellow Belt. Mashinini-Dlamini & van Waveren (2013), in turn, mentions that Green and Yellow Belts are employees in the business who have undergone a Six Sigma training that entitles them to participate as project members in Six Sigma projects. Taylor (2009) mentions that the project team's main purpose is to work to solve a specific performance problem and then implement developed improvements in the company's operations. According to the author, each team member has a responsibility to use Six Sigma methods as well as a responsibility for the team's overall success. Taylor (2009) concretizes a team member's responsibilities with help of using the following working tasks:

- Attend at all team meetings, prepared and on time
- Track performance and develop measurement values
- Collect, organize, and analyze data
- Analyze root causes that caused performance problems
- Develop solutions and improvements
- Recommend and implement solutions

When project teams are to be staffed, you should look for individual contributors with a strong drive to get things done, get the job done right and be good at collaborating with others (Taylor, 2009). According to Taylor (2009), effective team members are people who contribute to an orderly implementation of meetings and listen to others' ideas without prejudice. Furthermore, people are also good at assessing the benefits of ideas and solutions based on objective facts and data. At the same time, the author highlights that the team member's most important task is to follow assignments and measures.

Brenig-Jones & Dowdall (2018) claim that a Yellow Belt training lasts for up to two days. The education consists of training in basic applications of Six Sigma management tools (Kiran, 2017). Sörqvist & Höglund (2017), on the other hand, claim that a Yellow Belt training should last for 1 to 3 days. The basic training in improvement methods and tools can be applied to simpler interventions with a small scope (Pande, et al., 2014). The author also mentions that Yellow Belts tend to focus more on Lean-oriented methods rather than analytical variation-reducing skills. Pande, et al., (2014) believes that Yellow Belts are normally members of improvement teams rather than leaders. In larger organizations, the training is sometimes provided in the form of an e-course (Sörqvist & Höglund, 2017).

3.4.6 White Belt

Sörqvist & Höglund (2017) claims that a White Belt training should consist of a short introduction to Six Sigma and its working methods. The authors further highlight that the training usually is an information campaign aimed to all staff and consists of 2 to 4 hours. The content is adapted and depends entirely on the situation and intentions of the specific business (Sörqvist & Höglund, 2017). Furthermore, the author highlights that people sometimes instead talk about awareness training.

Brenig-Jones and Dowdall (2018) believes that White Belt training aims to create an awareness of Six Sigma. Furthermore, this includes introducing the approach and most importantly the principles to the employees. The author describes that the training also exists to demystify the method and deal with some of the jargon that is part of Six Sigma. According to Brenig-Jones and Dowdall (2018), the training can last from an hour up to a full day, depending on the organization's requirements. For large organizations, the White Belt education is sometimes offered like the Yellow Belt education as an e-education (Sörqvist & Höglund, 2017).

According to Magnusson, et al., (2003), White Belts are usually team members who are part of the project teams. The author claims that White Belts are usually people who work as front-line staff, operators, and clerks. These workers should be familiar with some of the tools used in the Six Sigma work. Magnusson, et al., (2003) also emphasizes that the White Belt training usually consist of a one-day course that is offered to a broad layer of operators and front-line staff, in some companies to all employees.

3.4.7 Organizational Structure

Pande, et al., (2014) propose two different ways of forming a Six Sigma organization, see Figure 11. The suggestions are based on the ways that the authors found common. The purpose of the figure is to show two different alternatives for distributing Six Sigma's different roles and how their reporting structure can look like (Pande, et al., 2014). Option A places Sponsor and Champion as responsible for controlling the projects while Master Black Belt is the coach for Black Belts and Green Belts who act as project managers. The Improvement team consists of team members or Green Belts. According to Pande, et al., (2014) team members should have good knowledge of the process and/or customer that is in focus in the project. Furthermore, members should also have access to data and be directly affected by the project.

Option B differs from Option A in that the Master Black Belt and the Black Belt are moved up one step in the hierarchy. In this structure, the Black Belt is given more responsibility for coaching the project and their leaders rather than running them as project leaders. The role as a project leader is instead held by Green Belts or a designated Team Leader.

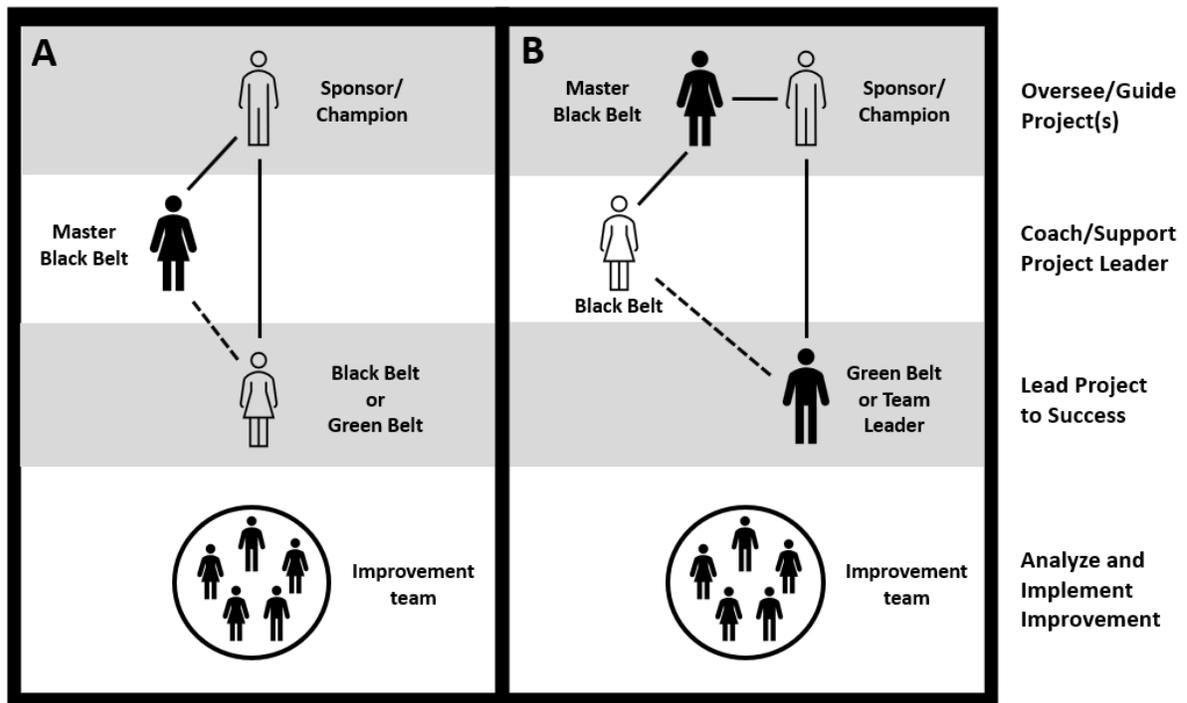


Figure 11. Two ways of arranging the Six Sigma project organization. Retrieved from (Pande, et al., 2014, chpt. 8.1).

4. Case Study at Skaraborg Hospital Group in Sweden

This chapter will cover the first of the two case studies. The case in question is Skaraborg hospital group's implementation of Six Sigma. All information about the case comes from documents and interviews.

4.1 Six Sigma at SkaS

The only large-scale implementation of Six Sigma in Swedish healthcare was carried out at Skaraborg hospital group (Lifvergren, et al., 2010). The authors explain that the initial start-up program aimed to reduce variation in the care processes so that both patient care and patient safety were improved by introducing Six Sigma. SkaS used a questionnaire to select the projects that were best suited for Six Sigma. In the article it is explained that the questions were constructed so it would be ensured that all projects selected for the program were manageable in terms of timeframe, the root causes were unknown, and being able to deliver a result within said timeframe. Furthermore, an organizational infrastructure for the projects were established by recruiting Black Belt candidates from interested employees who preferably worked at the clinic which the project was located. In addition to the Black Belts, a steering committee and a project group for each project were set up. The article also describes that everyone involved in the projects received different levels of Six Sigma training depending on which role they had in the projects.

The initial program at SkaS, which ran over a three-year period, resulted in 22 projects, where 20 were completed, and 15 were successful within the timeframe (Lifvergren, et al., 2010). In addition to the direct project results, the article states that the program also provided a lot of valuable insights into how and why Six Sigma can be successfully implemented in Swedish healthcare.

Lifvergren stated in the interview that he would not change much of how the implementation of Six Sigma was carried out at SkaS if he was to do it again. He points out that the initiative started on the right track immediately, which resulted in many years of successful projects and knowledge of improvement work being spread throughout the organization. Longevity is what Lifvergren highlights as the difficult part of these kinds of initiatives, to keep educating new employees and starting new improvement projects. The scope of the implementation at SkaS, starting with 7 improvement projects, is what Lifvergren considers to be reasonable and a good starting point for SkaS.

Chakhunashvili also stated in his interview that the implementation was successful and could be viewed as an inspiration for how to become successful in Six Sigma. If given the chance to do it again, Chakhunashvili would not change anything specifically. He highlights the high success rate of the projects to back up his statement. There were, however, some projects that did not reach their goals. As an example, Chakhunashvili points out a project revolving around waiting times at the emergency ward. Chakhunashvili states that everything was done by the book, but the result still did not bring reduced waiting times. Chakhunashvili wants to emphasize that sometimes even doing everything correctly still does not yield the desired results. It should not stop one from trying, though, says Chakhunashvili.

4.2 SkaS Six Sigma project methodology

All the information in chapter 4.2 of the case study comes from a single article published by the Swedish Association of Local Authorities (2008). With this being the case, no further references in the text were deemed necessary in chapter 4.2 of the case study.

The Six Sigma methodology is based on the DMAIC cycle that divide the project into five phases. At SkaS, however, they decided to alter the DMAIC cycle into seven steps instead by splitting the improve phase into three steps. The new altered Six Sigma project methodology model that SkaS used consisted of:

1. Clarify conditions (Define)
2. Mapping current situation (Measure & Analyze)
3. Find root causes and general improvement ideas (Analyze & Improve)
4. Set goals and plan how to reach them (Improve)
5. Design and test solutions (Improve)
6. Implement solutions (Improve)
7. Verify goals and secure new level (Control)

4.2.1. Clarify conditions (Define)

The first step is to clarify the conditions for the project and establish it with the sponsor/project owner. Here it is important to underline the aim and the expectations of the project so that misunderstandings and uncertainties can be avoided. The projects background, purpose, and potential should be defined, along with the financial goal and the limitations. Furthermore, the process that is to be target needs to be identified and an action plan for the project is developed and presented for the project group.

4.2.2. Mapping current situation (Measure & Analyze)

In the second step the prerequisite for the process is identified and data is collected to create a clear picture of the current situation. Mapping also includes identifying the flows of the process how it is connected to suppliers and customers, along with the in- and outputs of the process. Statistical methods are used to see the variation of the process and to be able to make decisions based on facts. Lastly, the step includes efforts to identify other possible organizations and processes to compare with.

4.2.3. Find root causes and general improvement ideas (Analyze & Improve)

The work is centered around finding reasons of variation and the root causes connected to them, based on the mapping done in the previous step. It is important here that the solutions for sure tackle the underlying reasons of variation, to ensure that the solution does not just fix the symptoms momentarily. At the same time, the project leaders start to generate improvement ideas and hypothesis to confirm or reject. The projects improvement potential gets updated with the new information.

4.2.4. Set goals and plan how to reach them (Improve)

Project management continues their work with possible solutions based on the root cause analysis. The improvement potential and how much can be saved is calculated for each solution and the steering committee decides which solutions to be included. The goal of the project is specified, where the expected result and deliveries are established together with the sponsor/project owner. An action plan for each selected solution is developed.

4.2.5 Design and test solutions (Improve)

A detailed description of the selected solution(s) is conducted and tested before implemented completely. If there are more than one solution, the solutions are continuously planned, implemented, and verified. The verification is done with statistical methods. Those solutions that are performing poorly and do not meet the desired results gets either rejected or adjusted before being fully implemented. The action plans updated continuously when new information is gathered.

4.2.6. Implement solutions (Improve)

This is the most critical step, as it is here the actual solution will get implemented fully. Previously, the solutions have only been planned and tested. It is important to follow and adjust the action plans to keep the project focused. The steering committee follows up on the action plan and the deliveries of the project.

4.2.7. Verify the goals and secure new level (Control)

When the solution is implemented and the process is improved, the next step is to ensure that the improvement is sustained, and that the organization does not fall back into the same old routines. This can be done by education/training and updated work instruction/routines. To follow up on the further development of the process, routines for continuing the monitoring of the process need to be present. The statistical tools for monitoring and controlling the process needs to be specified. It is also important that it is clear who is responsible for the new working routines. There must be someone responsible the continuous improvement efforts with small adjustments and continuous improvement. This person is also tasked with evaluating the process regularly and ensuring that the people working with the process gets the support they need. A smart way of doing this is by deciding a process owner that is responsible for the process being both able to achieve its goals and efficient.

4.3. Critical success factors at SkaS

The critical success factors when SkaS implemented Six Sigma were many. They have been categorized the same way as in chapter 3.2, with some success factors not being mentioned in the case study and a few others being added. It should be mentioned that SkaS has not focused on highlighting CSF for their implementation. In the articles that have been written about the case, there is, however, a lot of information that can be categorized under the CSFs from the literature. The information from articles and interviews is therefore summarized and presented under the respective CSF below.

4.3.1 Managements Involvement and Commitment

A key prerequisite for a sustainable quality effort in the long run is the managers commitment and support (Sveriges Kommuner och Landsting, 2008). The article describes that at SkaS the strategic management team drove, supported, and encouraged the quality efforts. It further highlights that knowledge and commitment for development issues is equally important at all levels of management. At SkaS there is a long-term development program for managers, where all operations managers and first line managers receive education in improvement efforts continuously, according to the article. Furthermore, the managers are involved at all major Six Sigma improvement projects by being in the steering committee.

SkaS investigated what made some projects fail while others were successful (Lifvergren, et al., 2010). Why some projects failed, according to the authors, was identified as the manager's lack of knowledge about the importance of project communication, as well as the lack of being involved in the project physically. Additionally, the authors stated that project managers did not receive the support from the mentor that was needed to narrow down the project sufficiently. The reasons for the projects failing brought up in the article can be summed up with both the mentor and project managers being inexperienced in this new way of working. These project failures, combined with the successful ones, did however provide SkaS with a few critical success factors for ensuring the success of future projects. There were five critical success factors identified in the article: commitment from both managers and the steering committee, co-workers, and physicians' involvement, sticking to the DMAIC cycle, iterative implementation of the proposed solutions, and continuous communication of the works progress.

When SkaS did a thorough investigation why one of their Six Sigma projects did not receive a successful outcome, they found that one of the reasons was that the management did not know the importance of being physically involved and engaged in the project (Lifvergren & Bergman, 2012). To ensure that this does not happen in future projects, SkaS top management put further emphasis on the importance of management involvement and commitment in their overall quality system.

Chakhunashvili highlighted in his interview that the full support from the hospital management was a critical success factor.

4.3.2 Training, Education, and Coaching

The implementation of Six Sigma at SkaS started as an eight-month long development program where theoretical education and practical work with real projects were combined (Sveriges Kommuner och Landsting, 2008). By having this combination, the article explains that the participants got the chance to practice what they had been taught directly. This is believed to help building the right set of skills. The article also mentions that in between every training opportunity, the participants received both theoretical and practical assignments to do at home. The purpose of the home assignments was for the participants to have time to reflect on when they had learned and to deepen their knowledge. In addition to the tuition the projects were also supported by people with special competences in statistical analysis.

Seven real improvement projects served as practice cases in SkaS's development program (Sveriges Kommuner och Landsting, 2008). The article states that all cases had to be manageable within the timeframe, limited in scope, and represent different areas in the healthcare. In the article it is explained that the idea behind this was that the program felt more meaningful when there were real cases to be solved, and not just a fictional one. Furthermore, at the beginning of each training opportunity the progress of the projects and the participants experiences were presented. This created a better understanding of each other's projects and roles. The participants in the development program, the Black Belts and Green Belts, were recruited internally from interested employees.

Chakhunashvili explained in his interview that the Six Sigma initiative started with two things: an organization for Six Sigma was established along with a training program for Black Belts and Green Belts. He also explained that the training program used an approach that combined theoretical studies with practical work in real projects. Furthermore, since healthcare employees are usually not accustomed to using statistical tools and techniques, the training program helped them get used to it. Chakhunashvili also said that at first, the people who were responsible for implementing Six Sigma at SkaS did not want to use too much technical terminology associated with Six Sigma and withheld from using the belt structure. With time, however, the employees themselves liked using the Six Sigma terminology as well as the belt structure. Chakhunashvili explained that in each iteration of the training program, roughly 10-15 new Black Belts were trained and for Green Belts, the number was even higher. Furthermore, he stated that the Black Belts worked in pairs on the projects. Overall, Chakhunashvili expressed that the training went well and that combining theoretical with practical work was a successful approach.

Nearly everyone at SkaS had a basic knowledge of Six Sigma, equal to that of a White Belt, according to Lifvergren. He explained that the Green Belts at SkaS received their education internally while doing Six Sigma projects while the project leaders. The Black Belts have received their education from different sources throughout the years, the first time with the support of a consultant, then internally, and currently at Chalmers University of Technology. Additionally, a person was recruited externally for the Master Black Belt role. The collaboration with Chalmers University is still ongoing and working well, according to Lifvergren. Together they educate employees from SkaS and perform strategic projects. Having a collaboration with a university is something that Lifvergren recommends. He also explained that the financial part of setting up a course for the employees at SkaS has been shared between the parties. He also said that training for the various belt levels followed the industry standard that is discussed in, for example, *Six Sigma: The Pragmatic Approach* written by Magnusson, et al., (2003).

Experiences from a failed Six Sigma project at SkaS also highlights the need of an extensive Six Sigma training program (Lifvergren & Bergman, 2012). The authors identified that one of the reasons for the project failing was that the scope Six Sigma education was too narrow. To fix this problem, SkaS revised their Six Sigma education and training program, making it longer and containing other principles as well such as Lean.

4.3.3 Linking Six Sigma to Business Strategy

At SkaS the project selection had a different perspective than what it usually has in Six Sigma (Lifvergren, et al., 2010). The authors explain that rather than selecting projects based on the cost-of-poor quality, the majority of the projects were selected based on the patient safety benefits. Even with this approach, the authors state that many of the projects were proven to be both financially beneficial as well as increase patient safety.

4.3.4 Organizational Infrastructure

Being able to understand variation, both wanted and unwanted, is fundamental for reaching high levels of quality and is found in the Six Sigma method (Sveriges Kommuner och Landsting, 2008). It is stated in the article that is why Six Sigma has become an integrated part of operational development at SkaS, and subsequently Six Sigma becoming an integrated part of Ska's improvement efforts. In the article it is explained that to enable this, SkaS developed an infrastructure to promote the improvement work. This led to that in 2007 SkaS had roughly 30 project leaders that lead their own improvement projects and had the competence equal to that of a Black Belt. In the article it is also explained that most of the project leaders had a background in the medical field, such as nurses or doctors, but there were also leaders with a background in economics, physiotherapy, occupational therapy, and even engineers. Furthermore, the participants that assist in the projects were recruited from interested employees where the project was taking place. This made the project groups consist of a wide array of professions, often medical secretaries, doctors, nurses, and physio therapists.

Given that improvement projects come with a huge potential, it is important to provide all the resources needed to realize that potential (Sveriges Kommuner och Landsting, 2008). In the article it is stated that Black Belts at SkaS usually worked full- or half-time with Six Sigma projects. This could, however, differ depending on which phase the project was in. Furthermore, it is beneficial to let Black Belts work in pairs on the projects. This enables the Black Belts to discuss ideas and support each other, without the actual time spent on a project increasing. The article highlights providing resources for the projects as a necessity, which is enabled by having an infrastructure with clear roles of every aspect surrounding the projects. According to the article, most critical role for the projects at SkaS were the Black Belt, and that they had the right drive, commitment, and personal characteristics.

Chakhunashvili also mentioned that one of the success factors for the Six Sigma implementation at SkaS was that there were different professions involved in the process. There were physicians, economists, and engineers who all brought their own unique set of skills. The interviewee stated that one of the biggest concerns when recruited was that he was not familiar with the healthcare industry. This turned out to be a benefit, as the group could learn from each other.

A key factor to the success of the program was the involvement of co-workers (Lifvergren, et al., 2010). The authors state that everyone that was involved in the projects in some way took a short course that made them familiar with the core concepts of Six Sigma, employees and managers alike. This together with the mindset of learn-by-doing, made each project a learning experience that continued beyond the project's limitations. As a result, other improvement

initiatives were taken in other parts of the process, according to the authors. The authors highlights that a contributing factor to getting the co-workers committed to the cause could be the fact that more focus was put on involving the whole project group, rather than leaving a lot to the Black Belt.

When SkaS ironed out why one of their Six Sigma projects failed, they found one of the reasons being that the coach did not support the Black Belts enough in delimiting the scope of the project (Lifvergren & Bergman, 2012). This experience highlights the importance of having a clear infrastructure where every role plays an important part in the project process. SkaS decided to revise their project delimitation template and update their project methodology to ensure that enough support was given to the Black Belts in future projects.

4.3.5 Project Prioritization and Selection, Reviews and Tracking

SkaS identified that to succeed in Six Sigma, the projects must be well defined and possible to complete within a reasonable time frame (Sveriges Kommuner och Landsting, 2008). Furthermore, the project should also have a high possibility of reducing costs or improving customer satisfaction. Also, if the project drags and is not completed within the time frame, there is a risk of the organization losing focus. In the article, criteria for project selection specified is described as a critical success factor. The article suggests that the criteria for selecting projects could be being more resource efficient, reducing the overall healthcare costs, increased patient satisfaction or safety, or improving the employee's work environment.

Having a tollgate after each phase ensures that everything is completed, and the project stays on track (Sveriges Kommuner och Landsting, 2008). It also keeps the sponsor/project owner and the rest of the steering committee informed throughout the course of the project. At SkaS, every phase of the project's model consists of different tasks, tools, and checklists of what is needed to complete the phase. This provides clear goals and a structured way of working which ensure that the project reaches all the way.

At SkaS, a database for potential larger improvement projects was established with the intent that a new project is started as soon as a project leader is available (Sveriges Kommuner och Landsting, 2008). It is stated in the article that the local departments themselves collect project ideas in the database and later selects which ones to take on. SkaS also provided resources to search for and collect data from the organizations different databases.

Lifvergren stated in his interview that a key part is to set up a project bank where possible new Six Sigma projects can be stored. This facilitates new projects being started as soon as a project is completed.

To make Six Sigma fit into the healthcare context, Chakhunashvili stated in his interview that the main adjustments that took place were how the goals for the projects were set. The goals for Six Sigma are normally expressed in financial terms, however, Chakhunashvili explained that at SkaS the focus was not on how much money a project will save, but rather on healthcare quality and improvements. The savings were considered a bonus that many projects brought. A reason for focusing on healthcare quality and improvements was that it was easier to motivate the employees, said Chakhunashvili.

4.3.6 Linking Six Sigma to the Customer

Even though Six Sigma has its origins in the business sector, the method is still suited for the public sector as well (Sveriges Kommuner och Landsting, 2008). According to the article, what could be considered new or foreign in healthcare is the result-oriented approach where goals are often expressed in financial terms. It should, however, be seen as getting more care for the money. The article suggests that Six Sigma is a well-suited method for healthcare as the organization is knowledgeable and used to scientific analyzes. With the goal of Six Sigma being to reduce variation, the article states that it is important to have a deep knowledge about the process and the prerequisites of it. This is to be able to identify what is random variation and what can be targeted. Being more process focused puts the customer perspective in focus, which in the article is described as perhaps the most important aspect. The focus should be how the process can be improved to better meet the customers' demands, according to the article.

4.3.7 Understanding the Six Sigma Methodology, Tools, and Techniques

When it comes to how Six Sigma should be done, the important aspect is having a standardized project approach with well-defined steps and structured decision making (Sveriges Kommuner och Landsting, 2008). This is something that the DMAIC model in Six Sigma handles well.

Six Sigma excels at building competencies in an organization according to Lifvergren, with the most important part being understanding variation. Lifvergren stated in his interview that the fact that the focus of Six Sigma is process variation, and that the method uses tools and techniques to access it, is what makes it stand out and be a successful addition to other improvement methods. Six Sigma also utilizes data analysis in a way that other methods do not, which is necessary to take the next step in improving healthcare, according to Lifvergren. Furthermore, the organizational structure surrounding Six Sigma could be used as a guide in how knowledge can be spread throughout the organization.

Lifvergren also states in his interview that at the beginning of a new initiative it is important to have a clear approach to how the projects are to be conducted. With time, however, this becomes less and less important as the organization will find its optimal working method with time.

4.3.8 Cultural Change

The culture in the organization is the most important aspect, rather than the tools that are being used (Sveriges Kommuner och Landsting, 2008). Furthermore, the article describes that to be successful in quality development there are important principles that must be embedded in the organization. For SkaS, those principles include having a patient focus, having a holistic view, connect the improvement work with healthcare processes, base decisions on facts, include all employees, and ensuring the top managements engagement. If an organization manages to maintain these principles presented in the article, the organization can assimilate new tools and methods and use them adequately.

To keep the participants inspired throughout the Six Sigma program, guest lecturers from both universities and the business sector got invited (Sveriges Kommuner och Landsting, 2008). There was a conference at the end of the Six Sigma program at SkaS where the participants presented the results of their projects and got their diploma.

4.3.9. Communication

Lifvergren points out that the effects of the implementation must be visualized and spread in the organization right away.

Communication is also important during the run of the projects, as pointed out by Lifvergren & Bergman (2012) when they investigated why one of SkaS Six Sigma projects failed. The authors identified problems with both project communication and communication between the Six Sigma coach and Black Belts. Their solutions to the project communication issues were to revise the overall quality program, revise their template for project communication and problem solving, and set up a parallel learning structure to accelerate learning.

4.4 Infrastructure and roles

All the information in chapter 4.4 of the case study comes from a single article published by the Swedish Association of Local Authorities (2008). With this being the case, no further references in the text were deemed necessary in chapter 4.4 of the case study.

In this chapter the different roles for the Six Sigma projects and how they were organized at SkaS is presented.

4.4.1 Steering committee (Sponsor/Champion)

The ones providing the Black Belt with the improvement projects and takes decisions in key areas are the steering committee. Additionally, they approve the project's goals and sub-goals, and makes sure that the project delivers what it should in all phases.

4.4.2 Coach (Master Black Belt)

The Master Black Belt should support the Black Belt and the whole project group in specific questions regarding tools and techniques. The Master Black Belt also play a key role in making the project progress by coaching the Black Belt in project management. Supporting the Black Belt in securing the employees commitment to new changes and working methods is also an important part for the Master Black Belt.

4.4.3 Project leader (Black Belt)

The Black Belt's main responsibility were to drive the improvement work forward. A Black Belt must be committed and have great stamina when it comes to always striving to reach the project's target. The Black Belt must also be authoritative and question old ways of working, even if it might yield consequences for others. Being able to get the employees enthusiastic and aboard on the project is also required for a Black Belt. The role of the Black Belt is an outgoing one where data is collected, and decisions anchored, within the organization.

Furthermore, the Black Belt should have a holistic view while being analytical. Combining having an eye for details with being able to see the bigger picture. Being able to adapt to and make changes based on new information is also a key characteristic. To ensure that a Black Belt possesses all stated characteristics, a thorough education and training is required.

4.4.4 Project participants (Green Belt)

The Green Belts should work as support for the Black Belt and participate in the improvement group. A basic training in Six Sigma and knowing how to use basic quality tools is required. Green Belts work part time with the projects.

4.4.5 Reference group

Other stakeholders in the project can participate through a reference group that is being provided information about the project regularly. These stakeholders can be union representatives, representatives for owners etc. The purpose of the reference group is to enable valuable insights for the projects from areas outside of it. The difference between the reference group and the steering committee is that the reference group does not get to make any decisions.

4.4.6 Organizational structure

Figure 12 below help visualize how the organization for the Six Sigma projects at SkaS structured. The Black Belt are the central part as the project leader and is the one who handles the contact and communication of the other parts in the project organization. Having the Black Belt as the central part of the projects were specifically important in the training program for them to get the experience of leading a Six Sigma project. The project participants consisted of both Green Belts and White Belts however, not only Green Belts as the figure indicates.

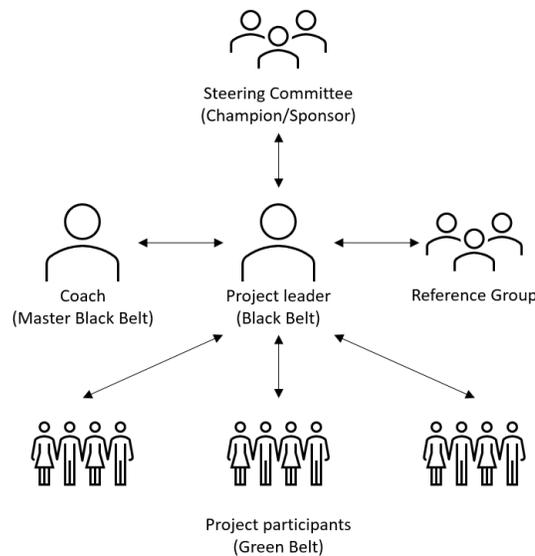


Figure 12. The organizational structure that SkaS use for their Six Sigma program. Based on (Sveriges Kommuner och Landsting, 2008, p. 27)

4.5 Healthcare specific difficulties for Six Sigma

SkaS identified several problems that are unique to healthcare when it comes to improvement work and Six Sigma that are not mentioned in the literature (Sveriges Kommuner och Landsting, 2008).

Firstly, it is highlighted in the article that there is a lot of natural variation in a healthcare process, which makes the efforts to reduce variation a more complex matter. Another aspect the article takes into consideration is the ethical one, as the variation between patients is a desired and necessary one. The more complex process opens the door for new solutions and new ways of identifying root causes for illnesses and healthcare injuries.

Swedish healthcare claims to be process oriented, but with a Six Sigma implementation it becomes evident that some processes are still poorly developed (Sveriges Kommuner och Landsting, 2008). Additionally, the article points out that big patient processes lack goals and measurements, as well as standards for the continuous improvement work. Because of this, the article states that there can be somewhat difficult to identify strategic improvement projects. Furthermore, much time need to be spent on clarifying which process is to be improved.

In SkaS case, lack of data also led to a higher reliance of the more elemental quality tools since the data available were often discrete data (Sveriges Kommuner och Landsting, 2008). SkaS also found that processes with clear roles and active improvement work have an easier time integrating the solutions found in the Six Sigma projects. The article describes that in some projects the most important result was that the process got established, which enables another Six Sigma project further down the line.

SkaS found that the financial calculations for the projects were difficult since there were no model for how to calculate quality gains in improvement projects in Swedish healthcare (Sveriges Kommuner och Landsting, 2008). In the article it is explained that even in the cases where the project generated a successful result, SkaS found it difficult to translate it into concrete resource redistribution. The successful results from a patient perspective fizzle away when saved resources are redistributed. SkaS concludes that even if all projects should originate from quality deficiencies in the customer perspective, more resource-oriented projects are also needed to take advantage of the gained resources.

The experiences that SkaS has drawn from their years of working with development efforts is that the key is having a long-term focus (Sveriges Kommuner och Landsting, 2008). It is stated in the article that offensive quality management is about basing the improvement work on the patients' expectations and needs. At SkaS, this translates to their pillars in development work, which is management's commitment, evidence-based healthcare, involving everyone, process oriented, and having a holistic view. To be successful in this strategy according to the article, the hospital must have knowledge and competence to work with improvement in the daily work and in larger projects. For SkaS, Six Sigma has become a successful method for taking on the larger projects.

5. Identifying Critical Success Factors in Swedish Healthcare

This chapter presents the results of the analysis done to answer the first research question. The analysis consists of comparing CSF from the literature with CSF identified in the SkaS case. The analysis is done for each identified CSF separately.

5.1 Critical Success Factors

The critical success factors identified in the literature study are used as a basis in the analysis of research question 1. The analysis compares the material from SkaS with the critical success factors previously identified in the literature study. The purpose of the analysis is to determine whether the CSFs addressed in the literature also fit in a Swedish healthcare context or not.

The material published on the implementation of Six Sigma at SkaS does not focus on determining the CSFs. Part of the analysis has therefore consisted of examining the material on SkaS in detail. The purpose of this was to identify the information from the SkaS case that matches the previously identified CSF from the literature study. In this way, it was possible to determine the CSF that was important when SkaS implemented Six Sigma.

The critical success factors from the literature constitute the main headings in the chapter. Under the main headings, the analysis is gathered on whether the SkaS case agrees with the literature or not.

5.1.1 Managements Involvement and Commitment

The most commonly occurring critical success factor in Six Sigma literature is managements involvement and commitment. In addition to it being the most common CSF, it is also the most important one (Henderson & Evans, 2000). Furthermore, it is argued that achieving this CSF also facilitates other CSF to be achieved as well, such as organizational infrastructure, cultural change, and communication (Henderson & Evans, 2000; Goldstein, 2001).

This CSF is also an important part of the Six Sigma efforts at SkaS to make Six Sigma sustainable in the long run (Sveriges Kommuner och Landsting, 2008). The CSF was achieved by having the strategic management team being the ones that led the improvement efforts, by for example being a part of the steering committee in the Six Sigma projects. Additionally, it was highlighted in the article that SkaS have a development program for managers that focuses on improvement efforts. SkaS also identified this CSF when they investigated why a Six Sigma project turned out unsuccessful (Lifvergren, et al., 2010).

With this CSF being the most frequently occurring in the literature and a central part of SkaS improvement efforts, it can be concluded that this CSF is important when implementing Six Sigma within a healthcare context.

5.1.2 Training, Education, and Coaching

With Six Sigma being a statistical method with a wide array of tools, it is important that everyone at the organization working with Six Sigma receives training and education (Henderson & Evans, 2000). Preferably, the training starts with the managers and then extends to the rest of the organization that will be a part of the Six Sigma efforts (Brue, 2002). Since there are different clearly defined roles in Six Sigma, the training and education program should reflect that as well, having every employee receiving adequate training to perform their role. Emphasis should be put on the quality of training and education program, rather than focusing on involving a certain number of employees (Goldstein, 2001).

SkaS Six Sigma implementation started with setting up a training and education program that combined theoretical and practical training (Sveriges Kommuner och Landsting, 2008). The program integrated real projects from the organization, giving the employees a chance to try out their newly taught skills. Chakhunashvili highlighted in his interview the need of getting employees familiar with and comfortable using statistical tools, which the training program provided. Furthermore, Lifvergren explained that SkaS had different training programs for different roles and that the Black Belts have received their training from different sources over the years. Chakhunashvili stated that in each iteration of the training program 10-15 new Black Belts and an even greater number of Green Belts were trained.

There is no doubt that training, education, and coaching is a CSF for implementing Six Sigma in a healthcare context. Perhaps even more so than normally, since Six Sigma is not a widespread and commonly used method in Swedish healthcare. Its statistical approach may also be new to many healthcare employees, making the training in these areas extra important.

5.1.3 Linking Six Sigma to Business Strategy

Linking Six Sigma to business strategy is a frequently mentioned CSF in the literature. It is described as aligning the goals Six Sigma projects with the overall goals of the organization (Magnusson, et al., 2003). This link was established at SkaS with the projects focusing on what is a very important part in healthcare: the patient perspective (Lifvergren, et al., 2010). By having this focus, the projects often became both financially beneficial and beneficial for the patients.

It can be concluded that linking Six Sigma to business strategy is an important part of implementing Six Sigma. In a healthcare context, the focus can be shifted away from the financial aspect and instead be put on aspects benefiting the patients. Nonetheless, a connection between the Six Sigma projects and the business strategy needs to be established.

5.1.4 Organizational Infrastructure

Organizational infrastructure is one of the critical success factors that is mentioned most frequently in the literature. Henderson & Evans (2000) highlights the importance of specifying and defining the role and responsibilities of each team member. They suggest that this can be implemented in practice by creating a clearly defined and evident organizational infrastructure. Sörqvist & Höglund (2017), in turn, describe that traditional improvement work has been carried out with the help of an ad hoc basis. They believe that this leads to cumbersome

organizations that go slowly. The authors consider that the introduction of clear infrastructure can be used to avoid an organization working on an ad hoc basis.

SALAR (2008) write in their article that SkaS focused on developing an infrastructure to promote development work. They describe the implementation of an infrastructure as crucial to make it possible to understand both desired and unwanted variation to be able to achieve a high level of quality according to the Six Sigma method. Lifvergren & Bergman (2012) describe that there were problems with the coach not supporting the Black Belts enough when delimiting the scope of the project. The authors believe that this experience further emphasizes the importance of having a clear infrastructure where each role is clearly defined.

There is no doubt that Organization Infrastructure should be seen as a CSF for Six Sigma in healthcare. The CSF is frequently mentioned in the literature and great emphasis is also placed on the factor in the material compiled on SkaS.

5.1.5 Project Prioritization and Selection, Reviews and Tracking

Before a project is selected for Six Sigma, there needs to be an evaluation to ensure that the project fits the methodology. Otherwise, the project risks ending up being unsuccessful. Furthermore, Goldstein (2001) suggests that there should be a standardized process where several criteria are evaluated to establish if the project is suitable or not. Following up the project, both during the progress and after the project is completed, is equally important as selecting, as having standardized project reviews can eliminate barriers that otherwise would hinder the progress of the project (Antony & Banuelas, 2002).

SkaS used a standardized process when selecting Six Sigma projects to confirm that the suggested project was in fact suitable for Six Sigma (Sveriges Kommuner och Landsting, 2008). Projects that were selected needed to be beneficial both in financial terms and for the patients, with Chakhashvili pointing out in his interview that more emphasis was put on the patient perspective to make the employees more motivated. Furthermore, the projects also needed to be completed within a certain timeframe (Sveriges Kommuner och Landsting, 2008). SkaS also set up tollgates after each phase to keep the steering committee informed of the progress and ensure that the project would reach its end goal (Sveriges Kommuner och Landsting, 2008).

It is safe to say that project prioritization and selection, reviews and tracking is a CSF when implementing Six Sigma in a healthcare context. Both in the literature and in the SkaS case, a lot of weight were put on making sure that the projects suit the Six Sigma methodology. The exact criteria for if a project is suitable might differ, but there should be a standardized process for prioritizing and selecting projects. Likewise, a standardized process for reviewing projects also needs to be established.

5.1.6 Linking Six Sigma to the Customer

All organizations must relate to meeting the needs of their customers (Goldstein, 2001). Furthermore, the author believes that customer-focused improvement work also leads to additional benefits. Both Antony, et al., (2007) and Linderman, et al., (2003) highlight that it

is important to reduce defects in processes based on the customer's needs to increase customer satisfaction. Linderman also highlights the benefits of Six Sigma advocating setting goals from an objective perspective. This leads to the goals being set based on the customer's requirements instead of based on internal considerations. Cho, et al., (2011) claim that implementation of Six Sigma achieves the highest effect when it is based on a clear customer perspective.

The article Sveriges Kommuner Och Landsting (2008) describes the importance of working to reduce variation in processes. Furthermore, it is mentioned that it is important to distinguish between random variation and the variation that can be counteracted. They also highlight that being process-focused leads to the customer perspective being put in focus. They highlight the customer perspective as perhaps the most important aspect and mention that the focus should be on improving the process so that it better meets the customer's requirements.

There is no doubt about that both SkaS and the literature agree that Linking Six Sigma to the Customer should be seen as a Critical Success Factor. In the literature, the concept is widely known and is often mentioned. SkaS also places great emphasis on the improvement work having a clear customer focus. Both SkaS and the literature highlight that the customer is positively affected by working with reduced variation in processes. Both in the work of reducing variation and setting goals for the work, the customer should be at the center

5.1.7 Understanding the Six Sigma Methodology, Tools, and Techniques

Henderson & Evans (2000) stated that the employees that receives Six Sigma training will be taught tools in three main areas: statistical, process, and team tools. The training will prepare the employees for future Six Sigma projects by making them familiar with and understanding the methodology and the corresponding tools and techniques. This is something that is also highlighted by Antony & Banuelas (2002) in their article. Hahn (2005) suggests that by having a good understanding of the tools and techniques, the employees can put them into use effectively.

In the SkaS case, they highlight the importance of having a standardized, well-defined, project methodology, which they believe Six Sigma provides (Sveriges Kommuner och Landsting, 2008). Furthermore, Lifvergren pointed out in his interview that Six Sigma is good at building competencies and understanding of processes. He also said that the Six Sigma tools and techniques were a good complement to SkaS other improvement methods. Additionally, Lifvergren claims that using the organizational structure of Six Sigma gives an idea of how knowledge can be spread in the organization. Lastly, he stated that in the early phases of Six Sigma implementation it is important to follow a strict project methodology, but that with time that importance fades naturally.

In both the literature and in SkaS case, understanding of Six Sigma methodology and its tools and techniques is a CSF. This CSF is also having a direct connection to another CSF (training, education, and coaching) further solidifying the importance of this being achieved. A Six Sigma implementation in healthcare would most likely be unsuccessful if this CSF is not fulfilled.

5.1.8 Cultural Change

Cultural change is listed as a CSF in 18 of the 41 sources reviewed in the literature study. A reason for striving towards cultural change is that when achieved, the employees will be motivated to work for improvement (Antony & Banuelas, 2002). Cultural change does not simply happen by implementing Six Sigma, however, but can come from knowledge and experiences from working with the method (Firka, 2010).

Cultural change is also deemed very important in SkaS case, with them arguing that it is even more important than the tools and techniques being used (Sveriges Kommuner och Landsting, 2008). SkaS also identified that they had to embed certain principles into their organization to enable the culture to change. Additionally, they also had guest lecturers come and inspire the employees and to keep the motivation high and spread the results from completed Six Sigma project in the organization.

For SkaS, cultural change was one of the most important CSF when implementing Six Sigma. This experience combined with the high frequency it is brought up in the literature makes it no doubt a CSF when implementing Six Sigma in healthcare.

5.1.9 Project Management Skills

Brue (2015) mentions in his article that the right project manager, or Black Belts, is as vital as using the right Six Sigma tools and techniques. He further describes that a Black Belt should have good knowledge in both technical tools and statistical tools, communication, and motivation. Pulakanam & Voges (2010) identified Project Management Skills as one of the five most important CSFs in the study they conducted. Antony & Banuelas (2002) in turn claimed that Six Sigma projects often fail due to poor project management skills.

In the Case study at SkaS, Project Management Skills was not identified as a single CSF. Good project management skills are not mentioned as a critical success factor in either interviews or articles. However, the literature describes that it is important that Black Belts have sufficient project management skills. Black Belts or equivalent project management role is closely linked to the critical success factors, organizational infrastructure and Training, Education and Coaching. From this it can be argued that the CSF, even if it is not mentioned as such, can be found within other CSFs.

In any case, it cannot be claimed that Project Management Skills is an individual CSF within a healthcare aspect as it is not specifically mentioned in the material available about SkaS.

5.1.10 Communication

Lifvergren mentioned in his interview that it is important to spread the word about the Six Sigma initiative. He highlights that the initiative must deliver results from the outset. Furthermore, he claims that it is therefore important to communicate and show the result to the organization from start. This agrees well with the literature where both Goldstein (2001) and Anand (2008) highlight the importance of spreading the word about Six Sigma even before the implementation begins. Goldstein (2001) further writes that communication should take place both before and after implementation to involve employees to a greater degree. Anand (2008)

in turn accentuated that communication at an early stage can be used to detect employees' initial reaction and if necessary, make changes to the strategy.

Lifvergren, et al., (2010) from SkaS were also able to identify the importance of communicating during the run of the projects. They identified this factor in one of the projects that did not achieve its goals at SkaS. They discovered that the problem was due to both a lack of communication within the projects and between Six Sigma coaches and Black Belts. They solved the problems by revising the overall quality program, revising their template for project communication and problem solving and setting up a parallel learning structure to accelerate learning. In the literature, Henderson & Evans (2000) mention that a communication plan can be used to counteract employees' fear of change and fear of not living up to the new standards. This is well in line with the actions that SkaS took to ensure good communication within the organization.

There seems to be a good agreement between the theory and the case at SkaS that Communication is a Critical Success Factor in the Six Sigma work. The CSF is mentioned relatively often in the literature and is clearly mentioned in both the interview with Lifvergren and the other material about the implementation of Six Sigma on SkaS. It can therefore be considered reasonable that Communication is a CSF as Six Sigma is implemented within a healthcare context.

5.1.11 Linking Six Sigma to Suppliers

An extension of Six Sigma which can be beneficial is linking it to the suppliers (Antony & Banuelas, 2002). This does not have to be a full integration to the Six Sigma efforts but can be used to assist in certain areas of the projects (Firka, 2010).

The suppliers were not brought up once in the entire SkaS case. This being the fact, along with linking Six Sigma to the suppliers not being mentioned too frequently in the literature, makes it unconfirmed if linking Six Sigma to suppliers is a CSF when implementing Six Sigma in a Swedish healthcare context.

5.2 Summary of CSF within a Swedish Healthcare Context

Of the 11 CSFs identified in the literature study, 9 could also be identified in the case study at SkaS. The two critical success factors that differentiate between Swedish healthcare and the literature are *Project Management Skills* and *Linking Six Sigma to Suppliers* (see Table 6).

Table 6 A comparison between CSFs mentioned in the literature and in Swedish healthcare.

Critical Success Factors Identified in the Literature Study	Identified in the Case Study at SkaS
Management Involvement and Commitment	X
Training, Education and Coaching	X
Linking Six Sigma to Business Strategy	X
Organizational Infrastructure	X
Project Prioritization and selection, Reviews, and Tracking	X
Linking Six Sigma to the Customer	X
Understanding the Six Sigma Methodology	X
Cultural Change	X
Project Management Skills	
Communication	X
Linking Six Sigma to Suppliers	

6. Case Study of Previous Six Sigma Projects at Region Östergötland

This chapter covers the second of the two case studies. The case in question is located at Region Östergötland and handles their experiences from completing several Six Sigma projects in collaboration with Linköping University. The information is gathered from three different sources: two interviews with employees and the authors own observations.

6.1 Interviews with personnel from the Region Östergötland's previous Six Sigma projects

The material gathered for this case comes primarily from interviews conducted with the employees that have firsthand experience with working in Six Sigma projects at Region Östergötland. The findings from the two interviews are presented in the two chapters below.

6.1.1 Interview with project manager 1 (PM1) at Region Östergötland

About the interviewee

The interviewee has worked in the role as business developer in medical technology since 2016. She has previously also worked as unit manager and process leader and has worked 24 years in Region Östergötland. Her knowledge and experience from Six Sigma come from being project coordinator for two Six Sigma projects that Region Östergötland performed in collaboration with Linköping University. The role as project coordinator included being the students contact, the link between the students and the operations at Region Östergötland and handling the implementation of the results from the project. Additionally, she also participated in the work during all phases of the project.

The projects

The interviewee explained that the two Six Sigma projects she was involved in at Region Östergötland were very different from one another. In the first project, which was carried out in 2017, the identified problem were X-ray machines in mammography going out of function. The care process itself is very slim, with the patients being in and out of the process in roughly 7 minutes. A prolonged machine downtime results in many patients being affected negatively. The identified root causes for machine failures were dust gathering on the lens and one room being too hot, making the X-ray machine overheat. To fix these problems, the solutions generated in the project were changing the cleaning routines and adjusting the ventilation in one of the rooms. An additional identified problem was the long delivery time for fluorescent lamps to the X-ray machines. Since those needed to be changed intermediately it was decided to keep stock of the lamps to avoid an X-ray machine being out of use for an extended time.

The second project focused on a clinic's patient surveillance system. Originally, the problem was thought to be that the new system did not meet the requirements. During the project, however, it was identified that a large part of the problem was that the nurses that used the system did not have enough knowledge about it. The solution generated in the project focused

on two aspects. First and foremost, getting the nurses on board with the new system and configuring the system to better fit the specific clinic.

Six Sigma

The interviewee's experience with Six Sigma is that it has worked well, and that the method is well organized and structured. She also sees it as a benefit for healthcare overall that the method is data driven, which is something that Region Östergötland could be better at utilizing. The solution generation used in Six Sigma enables the projects members to think outside the box and come up with solution that otherwise might not have been thought of. Another benefit with Six Sigma that the interviewee has identified is that it includes a focus on the financial part as well. The financial aspect is otherwise something that the interviewee feel get overlooked when doing improvement projects in healthcare. What the interviewee thinks is the challenge of implementing Six Sigma at Region Östergötland is establishing the method in a healthcare context. It will also be a challenge using data analysis in a broader fashion.

Management's involvement and commitment

An important part for the implementation of a new improvement method to be successful, is that there is commitment to the implementation high up in the organization. It does not necessarily have to be difficult to establish the method in the organization, but it is vital for the method to be used efficiently. Introducing a new method use for improvement projects also requires getting everyone in the organization on board. Otherwise, the implementation will be unsuccessful. The top management must be involved and committed both during the implementation and afterwards when the method is being used.

Training, education, and coaching

It is very important to educate about the method to spread the knowledge about it within the organization. A key factor for the implementation to be successful is that there is adequate knowledge of the method and its tools.

Organizational infrastructure

The other improvement initiatives that Region Östergötland currently work with are using a central party that drives the initiative and that it is employees in the departments who work with it. This is something that the interviewee believes could work for Six Sigma as well. The projects can then, depending on the scope, either be handled entirely by the departments themselves or be more centrally managed. It is then important that there is a clear organization about how the results are disseminated within the business. Results from projects that aim to improve a specific process should be disseminated to other parts of the business that have the same or similar processes.

The interviewee thinks that the actual organization around Six Sigma does not have to be complicated if you are clear on what responsibility lies where during the implementation. There are roles within the region today that can serve as method support and educators. The department for business development has the competence to run and train employees in Six Sigma methodology. There is no need to create a new structure within the region, but it can be beneficial to build on the existing one. The various roles in Six Sigma can be integrated with the region's existing organization.

Project prioritization and selection, reviews, and tracking

Region Östergötland currently has no standardized way of selecting which projects to carry out. There is currently an approach on how to select projects at Region Östergötland, but it is not used in practice. Although everyone who works in the region basically work with the same problems and task, there is no widespread coordination around improvement projects. However, the region is looking at ways to coordinate this. The same applies to how to follow up a project's results.

Linking Six Sigma to the customer

The interviewee's experiences from the projects indicate that it is not a problem to bring the patient perspective into the Six Sigma projects. The calculations made in the projects help to quantify how many more patients can receive care if the solutions are implemented and the problems eliminated, at the same time as the financial gain is highlighted. Patient focus is central and a strength within the region. Six Sigma follows the same line and can create good conditions for a clear patient focus.

Understanding the Six Sigma methodology, tools, and techniques

For Six Sigma to become a well-functioning method at Region Östergötland, it is important to identify and understand what the benefit of the method is. The healthcare has a tradition that everything should be evidence-based. For this to also apply in the work with Six Sigma, it is important that there is adequate knowledge of the method within the region. Subsequently, it is also important that there is competence in using Six Sigma's tools in the right way. Knowledge of analysis and statistics tools must be broadened in the region.

Cultural change

Region Östergötland is a large organization that is slow to change, according to the interviewee. The change and improvement work are conducted locally at the departments, rather than together throughout the region. There is a will and ability to improve at the local level. However, it is more difficult to get the whole region to pull in the same direction when it comes to improvement work. The strategy and plans that are set up on a three-year basis are not fully followed. The departments out in the business run their own race and implement the initiatives and projects that they themselves think generate the most benefit. The interviewee believes that the initiatives taken in the business should be in line with the strategy that has been set up. To succeed in getting the departments to better follow the strategy the management are required to lead and support in it. However, it is difficult for a healthcare director or an operation manager to control the departments' improvement work as it is the head physicians who have the final say.

Project management skills

There is a need for someone who can explain the reason why something is done and what the point of doing it is. Furthermore, it is important that someone handles data, analyzes it, and translates it. Then it is also required that there are people in the business who can analyze the problem picture and use the results from the projects.

Linking Six Sigma to suppliers

Suppliers of, for example, equipment and systems must be able to provide data that the health service can access. An example of data that providers can provide is lead times. There are many different systems from different suppliers that needs to be available. That is why it is important to have a functioning cooperation between the parties.

Communication

Collaboration between different departments works well as there is a clear process for the patient that covers more than one department. In cases where there is no clear process connection, the cooperation between the departments varies. Much of the collaboration is based on the departments seeing a clear benefit in the collaboration. If the benefit of the collaboration is not anchored, there will easily be a feeling of "us and them" within the departments as there are usually no resources to spare to support other departments.

Data collection & IT system

A central part of Six Sigma is to analyze data. There is great potential in health care when it comes to data analysis as a lot of data is collected. The problem is that not all data is used and that how to keep records is not standardized. The reason why this is the case is that the health service often works on other premises than data. Six Sigma has the opportunity to strengthen the region's ability to analyze data. A key to getting better at data analysis is to look at how data is used in research projects and adopt it in the improvement work.

Implementation

For the implementation of Six Sigma to be successful, it is important to sell it. The method needs to be well rooted in the organization and it is important to have clear ownership and management of the method. Furthermore, competence is needed that knows when, how and what is to be achieved with the method. It is important to reach all the way until solutions are concretized and realized, and that the purpose of implementing the solutions is communicated. To avoid Six Sigma being underused, it needs to be crystal clear in which situations the method should be used.

6.1.2 Interview with project manager 2 (PM2) at Region Östergötland

About the interviewee

At the time of the project, the interviewee was employed as a healthcare developer at Motala hospital. The interviewee was employed at the medical specialist clinic which included several sections at Motala hospital, one of them being the geriatric department where the Six Sigma project took place. The interviewee has a background as a nurse.

The project

The project that the interviewee was a part of was focused on reducing the number of fall injuries at the geriatric emergency department (GAVA) and was carried out in the fall of 2021. A fall injury could occur any time during the patient's whole stay at the department. Because of this, there were several root causes identified. Two of those were that the patient received most of their visits from the staff in the morning rather than the afternoon and that there was a lack of standardized routines for the patient's toilet visits. The solutions for these root causes

were rather simple yet needed. The first being that the patient should receive more standardized visits in the afternoon and the second solution was to create and implement clear routines for the patient's toilet visits.

Management involvement and commitment

The interviewee does not primarily highlight the management's involvement and commitment as a single critical success factor. However, she mentions that commitment and interest are required in the department where improvement projects such as Six Sigma are carried out. The interviewee further emphasizes that the support of a development manager in certain parts is necessary to carry out successful improvement projects in the future in accordance with the Six Sigma method.

Training, education, and coaching

Employees at the medical specialist clinic and in other departments are relatively unfamiliar with the use of statistical tools. The interviewee therefore believes that an effort would be required to increase the competence of the employees in statistical tools.

Linking Six Sigma to Business Strategy

The interviewee highlights the importance of implementing Six Sigma as part of the existing improvement and quality work. She believes that Six sigma should be linked to current methods used in the organization. This is to avoid the staff feeling that methods are constantly being replaced by new alternative methods.

Organizational infrastructure

The business has previously worked to build up a structure around various improvement methods such as Lean. Within the framework of these methods, training has on some occasions been provided to a greater extent, including care developers, nurses, and assistant nurses. To provide knowledge to a larger proportion of the employees at MSK, a smaller number of employees have been trained to act as trainers/Lean coaches for other employees. The trainers were selected based on the employee's commitment to the method and improvement work in general. The trainers in turn had support from a higher level through coaching.

When the training program was implemented, a stronger climate was created for improvement work. The employees now had a model and process to use, which facilitated their improvement work. The business then further developed Lean by including more tools such as the Green Cross. A good culture around improvement work was created by providing a composite toolbox with different tools for working with improvement work.

The interviewee highlights two different ways to appoint the right people to the right roles in an upcoming implementation of Six Sigma. The individuals should either be allowed to register themselves as part of the initiative or be identified and selected by the management. To succeed in this, information should be disseminated via, for example, workplace meetings. It is also important to describe how the management intends to use the method, why, and what steps will be included.

Project prioritization and selection, reviews, and tracking

At present, there is no standardized way of selecting and prioritizing various improvement projects. The projects that are more comprehensive and involve several departments/activities are selected with a clearer structure than those at the department level. The projects are selected to a greater extent at the departmental level based on gut feeling. The interviewee believes that the Six Sigma method can strengthen how to select which improvement projects to carry out. This is done by implementing the define phase, where the suitability and profit in future projects are investigated, among other things.

Linking Six Sigma to the customer

The interviewee claims that Region Östergötland is generally good at working with a patient focus on improvement work. However, she also mentions that the organization can become even better at focusing on the patient. This is done by making the patient and their relatives more involved in the improvement work. According to the interviewee, it is easy to slip into focusing on the needs of the staff instead of the patient and their relatives.

The interviewee thinks that Six Sigma on many occasions mentioned and focused on the patient's needs and perspectives. This was done primarily by considering the staff's experiences from meetings with the patient. However, one thing that she mentions is that the project was limited in such a way that no patients actively participated in the work. She believes that the patient's participation in improvement projects is important. At the same time, she raises the issue of how the patient should be included in the practice.

Understanding the Six Sigma methodology, tools, and techniques

When the Six Sigma project was carried out at department 13 at Motala Hospital, the interviewee experienced that the method worked well and differed from other methods through the standardized working method/workflow. The new method that she had not worked with before contained a clear structure with different phases and focus areas. She appreciated clear time frames and a project-based workflow. The interviewee especially highlights the value of having a project manager who keeps the pace up and ensures that the project follows set time goals and expected results. Acting as a project manager is usually the interviewee's responsibility, but as someone else took on that role, she had time to assist the project manager with the information, data, and materials needed for the project's progress.

Cultural change

The interviewee believes that it varies at the individual level whether the staff in the region are open to new ways of working and tools or not. However, she mentions that there is generally a driving force to improve and change. Temporary focus areas have often been worked on to motivate staff to focus on specific areas. At MSK, for example, the employees themselves have determined that they want to measure the number of pressure ulcers that occur each month. Another example of willingness to change and improve is the work carried out at GAVA with a focus on fall injuries. In this respect, the employees have created a culture around being careful to report when fall accidents occur.

The interviewee mentions that it is very much up to the unit manager to set a culture and decide how to set up the work. For example, the Green Cross is used to include and update employees on the challenges and deviations that the department is facing to solve.

Before the pandemic, a day was also set aside at MSK with a focus on improvement work. Different departments then had the chance to present what they worked on in improvement work. In this way, a channel was created to spread knowledge and inspiration to other departments.

Project management skills

The interviewee emphasizes that it is important to have a project manager who is used to planning, running, and supporting projects. This is to keep the pace up in the projects, ensure that they proceed as intended, and reach their goals.

Communication

The interviewee claims that an important factor for the success of a Six Sigma project is clear communication with good foresight. This is because several parties from different departments are involved, which makes it a challenge to succeed in booking meetings where all parties can participate. She highlights, in particular, the problem of booking appointments with assistant nurses and nurses who do not work at the same time every week. This was discovered in the project that was carried out at GAVA as it was difficult to book times that suited everyone. It was often not difficult to get the schedules of the students, the improvement manager, and the department head together, but a challenge when an assistant nurse would participate. This was because she worked evenings in certain weeks when other parties worked during the day.

Data Collection & IT Systems

At present, data is collected in many different systems. Often the same data is reported into different systems as these are disconnected from each other, which entails unnecessary extra work. The systems are also not adapted in the way that the department itself and the care developers want, which means that they at GAVA also collect data in addition to the existing systems. In the Six Sigma project, information about which room the patient fell into was an example of something that the department itself reported in addition to the computer systems. There is a Business Intelligence unit in the region that is on hand when employees need to export data. However, this still requires knowing what information you want and where it is located. How difficult it is to export data from the system depends on where in the documentation tree the requested data is located.

The documentation templates and their structure are another aspect that determines whether data can be exported or not. One thing that was discovered in the project was that free text cannot be exported from the systems automatically. This meant that valuable information entered as free text was lost from the analysis work. There is thus a big difference between whether free text or fixed choices are used to succeed in exporting data.

There are routines around the design of the document templates. Some are determined at the regional level while others are determined at the MSK or department level. In the end, however, the individual level is also important as it is the individuals that enter data into the systems. It is also much more difficult to export data that affects the patient at the individual level. This was also discovered in the project when data was requested which was classified. This problem often arises when data is to be exported from, for example, patient records.

6.2 Observations from previous project at Region Östergötland

In the autumn of 2021, the authors of this thesis led a project within the Östergötland Region. The project was carried out as a collaboration between Linköping University and the Östergötland Region. The work was part of a Six Sigma education provided by Linköping University and was carried out at one of the region's departments, the geriatric emergency department (GAVA) at Motala Hospital. The purpose of the project was to use the Six Sigma method to reduce the number of fall injuries in the department.

During the project, observations were made by the authors that can be used in this thesis. The challenges and successes observed in the project are described below.

Obstacles when exporting data

The most obvious obstacle to driving the project forward in a simple way was data management. Exporting the necessary data was difficult and often took time. The following three reasons for this were identified:

1. A large part of the data exported was handled by Region Östergötland's Business Intelligence unit. The contact path between the project manager and the Business Intelligence department was experienced as long and the response time was often a critical moment. A Six Sigma project is dependent on data to be able to progress, which made the complicated contact paths a clear obstacle.
2. It was also obvious that the export of data was cumbersome for the Business Intelligence department. The challenges were to find the right way to export data and how to access this information in their systems. Data retrieved from journal systems is also confidential, which means that it needs to be deidentified to be passed on to those responsible for the project.
3. Much of the information that GAVA enters in, for example the journal system, is entered as free text. In cases where the information is entered as free text, the Business Intelligence department could not export the information from the system. They were only able to export data entered by fixed selections through, for example, a drop-down list or the like. This made it impossible to access free text that could contain important information about the patient.

Lack of standardized processes

The next thing that complicated the project was that there was no clear standardized process linked to what the project intended to investigate. Each patient's stay at the department looks different depending on, among other things, the person's illness problems, length of stay, and age. Each patient is also differently inclined to leave their bed and is therefore exposed to different risks of fall injuries.

Difficult to calculate financial gains

Estimating the size of the cost savings that can be made through the project's proposed solutions was difficult. The cost savings consisted mainly of shortened care time for the patient. A shortened care time means reduced costs in many areas, such as a reduced need for staff,

medicines, care places and medication, etc. As a shortened care period spans several departments and operations, it is difficult to make a correct calculation of the cost savings. This should be considered in healthcare improvement projects.

Fall injuries are also categorized in different degrees of severity depending on whether the fall led to more or less serious injuries. As fall injuries are categorized into different degrees of severity, it is difficult to say how many fall injuries of each severity that could be reduced through the project's proposed measures. This affected the calculation of the cost savings.

It was clear in the project that there is no simple and standardized way to calculate cost savings in the Region. An employee from the Region who is used to and works with similar calculations was helpful in the project. Despite this help, the aforementioned problems were obvious.

Important to secure time and resources

Running a Six Sigma project is not an easy solution that is over in a few days. It was obvious in the project that time and resources were critical factors. As the improvement project spanned several professions such as a project manager (the authors), department manager, business developer, and assistant nurse, a lot of resources were needed. Although the project manager carried out most of the statistical analyzes, the other employees participated in the work of determining the root causes and proposing appropriate improvement measures. This was done through meetings held at the hospital where the project was carried out. Gathering valuable information from employees working in the department was important to not lose ground to reality and the business. Available resources from both project managers and employees close to the process are therefore important.

Simple statistical tools

During the project it was found that using simple or basic statistical tools was sufficient. The data that was available for the project were discrete, making such tools as pareto charts useful. This shows that even if there is a need for statistical analysis in the projects, it does not have to be advanced for it to be successful.

A great need of training

There need to be a thorough training program for the employees for Six Sigma to be successful at Region Östergötland. The employees are eager to learn new thing and are open to adopting new methods that help them improve their healthcare, but do not currently have the knowledge or skills to operate Six Sigma projects themselves. This is not something unique for Region Östergötland. As evidence by the literature study, Six Sigma is not a simple method that can be successfully implemented without training the employees.

7. Identifying Critical Success Factors at Region Östergötland

This chapter presents the results of the analysis done to answer the second research question. The analysis is done for each identified CSF separately.

7.1 Critical Success Factors

The pattern used for this analysis is based on the results from the analysis done in chapter 5. The pattern was used to identify if the experiences from Region Östergötland's previous Six Sigma projects aligns the CSF found in chapter 5. The findings from the interviews and observations were compared to every CSF separately.

7.1.1 Management Involvement and Commitment

PM1 mentioned in the interview that for the implementation of any new improvement method, managements involvement and commitment is a CSF. PM2 does, however, not put as much weight on the importance of this CSF in her interview. Although, she does mention that a development managers support is needed for Six Sigma projects to be carried out successfully.

The reason for the two interviewees having different views of the importance of this CSF is unknown. Perhaps PM2 only looked at it from the perspective of carrying out the projects, while PM1 took a more holistic view. Even if the two interviewees do not share the same view on the importance of this CSF, it being highlighted by one of the interviewees as a vital part cements its importance.

7.1.2 Training, Education, and Coaching

PM2 highlighted in her interview that employees in the medical field are often unfamiliar with using statistical tools, thus bringing to light the importance of training and education. Likewise, PM1 sees training and education as a CSF for implementation. With both interviewees having the same opinion there is no doubt that training, education, and coaching is a CSF for Region Östergötland.

7.1.3 Linking Six Sigma to Business Strategy

Linking Six Sigma to Business Strategy is mentioned in the interview with PM2. She highlights that it is important to connect existing improvement and quality work with the Six Sigma implementation. Furthermore, she believes that this is extra important to ensure that the employees at Region Östergötland do not feel that new methods are constantly being introduced. The success factor can therefore be verified as a CSF for Six Sigma at Region Östergötland.

7.1.4 Organizational Infrastructure

One way of organizing the Six Sigma infrastructure is using a central party that drives the initiative, as suggested by PM1. She, among other things, also suggested that the organizational infrastructure should facilitate project result sharing. Most noticeably she brought up that there

perhaps is not a need to create an entirely new organizational infrastructure, since there are present ones that can be built upon.

PM2 did not, however, provide suggestions on how the organizational infrastructure should be constructed. Instead, she brought to light that Region Östergötland have an existing organizational structure for other improvement methods, such as Lean. She added that having this organizational infrastructure and training for the roles made the employees committed to the improvement work. Additionally, she gave her suggestion on how the employees should be recruited for the Six Sigma projects.

In our own experience when working with a Six Sigma project at Region Östergötland, we found that one of the most important part is securing the right resources for the project. We believe that having a clear organizational infrastructure where everyone working in the project has a clear role with different responsibilities and tasks is needed. This experience together with what the interviewees brought up makes it evident that Organizational Infrastructure is a CSF for Region Östergötland.

7.1.5 Project Prioritization and Selection, Reviews and Tracking

PM2 emphasizes that projects that span several departments have a higher degree of coordination than the projects that are implemented in the local departments. PM1 also mentions that there exists a certain approach on how to select projects within the Region, but that this is not complied with in practice. Furthermore, she writes that the organization is searching for ways to become better at coordinating the improvement projects and following up on its results. PM2 emphasizes that the Six Sigma method can be used to strengthen which improvement projects should be prioritized and implemented. She emphasizes the Define-phase as part of getting better at selecting the right projects.

There is no doubt that Region Östergötland lacks in systematically selecting improvement projects. This is an important part of Six Sigma that is addressed by both interviewees and should thus be seen as a CSF for Region Östergötland.

7.1.6 Linking Six Sigma to the Customer

Linking Six Sigma to the customer, or in this instance the patient, is a CSF both PM1 and PM2 agrees upon. PM1 said that patient focus is central in Region Östergötlands work, and something that she sees as a strength. Furthermore, she does not see a problem bringing in the patient focus in Six Sigma projects. PM2 mentions that Region Östergötland can become even better at putting the patients' needs first and suggests that patients can maybe be involved in the projects if possible. Both interviewees tell the same story: being patient focused is central healthcare, and both interviewees see it as a CSF.

7.1.7 Understanding the Six Sigma Methodology, Tools, and Techniques

PM1 claims that it is important to identify and understand the benefits of the method to make it work as intended in the Östergötland Region. She further writes that it is important that the organization acquires adequate knowledge about the method. She considers this extra important as there is a tradition in Swedish healthcare to work evidence based.

During her work with the Six Sigma project at Region Östergötland, she experienced that the method differed from other methods through its standardized workflow/method. She further described that some of the reasons why it was perceived as clear were that the working method contained a clear structure with different phases and focus areas. She also appreciated clear time frames and a project-based approach.

PM1 believes that knowledge of analysis and statistical tools must be broadened within the organization. Furthermore, she says that it is necessary to have a deeper knowledge and competence within the organization for the Six Sigma tools to be used in the right way.

7.1.8 Cultural change

PM1 said in her interview that Region Östergötland is a large organization that is slow to change but has a will for improvement work at a local level. PM2, on the other hand, believes that it varies at the individual level whether employees are open to change or not. She also mentioned that there is a general drive for improvement and change.

PM1 emphasizes that there is a strategy for improvement work that is updated every three years. At the same time, she emphasizes that the strategy is not fully followed. Furthermore, she claims that the local departments run their own races and carry out the projects that they see can create the most benefit for themselves. She also mentioned that it is therefore difficult to get the whole organization to work and pull in the same direction when it comes to improvement work.

PM2 said in her interview that the organization has previously used temporary focus areas to motivate employees to focus on specific areas. She also mentioned that MSK organized a day where different departments had the opportunity to present their improvement work. This was done to spread knowledge and inspire other departments.

After the interview with employees, Region Östergötland seems to struggle, like many other large organizations, with a certain resistance to change. At the same time, they emphasize that there is a will to improve healthcare, especially at a local level. Getting the whole organization to change together and work towards the same goal seems to be a key to achieving successful improvement work. Cultural change should therefore be seen as a Critical Success Factor also at Region Östergötland.

7.1.9 Communication

Both interviewees highlight communication as an important aspect of success with Six Sigma, albeit in different ways. PM1 states that communication works best when there is a clear process linked to the patient's healthcare. When a standardized process is lacking, it is more difficult to get the departments to cooperate. According to PM1, the difficulties in communicating and collaborating between the departments are based on the fact that they focus on what benefits themselves. This is because the departments are often under pressure in terms of resource availability. PM2, on other hand, describes that clear communication with good foresight in the projects is a CSF. She believes that it is extra important as the projects include several professions, which makes it complicated to book meetings and communicate.

Both interviewees highlight their experiences from the Six Sigma projects previously carried out at Region Östergötland. This means that they focus on communication within the projects rather than, for example, the management or the actual implementation of Six Sigma. However, both interviewees mention communication as a CSF to achieve success in the Six Sigma projects. Communication should therefore be seen as a CSF.

7.2 Additional Critical Success Factors for Region Östergötland

Here, an additional CSF that was not included in the pattern is presented. The CSF was identified in both interviews and the authors own observations and was therefore considered important to include.

7.2.1 Project Management Skills

Regarding project management skills, the two interviewed employees both brought up its importance, but in different ways. PM1 focused on having someone that identifies the problem picture and communicates why the projects is being conducted. PM2 on the other hand focused on the importance of a driver for the practical project progress, someone who plans, runs, and supports the project. What can be drawn from these two interviews is that project management skills are important in all parts of the projects, before, during, and after.

7.2.2 Linking Six Sigma to Suppliers

The only one that mentions anything about the critical success factor of linking Six Sigma with the suppliers is PM1. She emphasizes the importance of suppliers being able to provide relevant data for the Six Sigma projects. She also says that there are many different systems from different suppliers that must be available. She, therefore, highlights that there must be good cooperation between the suppliers and the Östergötland Region.

There is no detailed information found in the interviews about the critical success factor of Linking Six Sigma to Suppliers. One reason for this may be that the people interviewed only participated in a few Six Sigma projects. The importance of linking the Six Sigma work with the organization's suppliers can be a factor that does not become visible until a problem arises in a specific project. This may be one of the reasons why the interviewees did not mention much about the success factor.

PM1 reported, however, that she sees the importance of the success factor being met. Therefore, Linking Six Sigma to Suppliers can be considered a success factor in Region Östergötland.

7.2.3 Data Collection & IT System

Both interviewees stressed the importance of data collection and having systems that enables it. PM1 said that the fact that healthcare generally collects large amounts of data as a great potential when it comes to performing data analysis in Six Sigma projects.

PM2, however, identified potential issues there, as data is collected in many different systems that are not connected to one another. This experience is something that us authors shared as

well when we performed our Six Sigma project at Region Östergötland. Additionally, PM2 also highlighted the fact that systems are often not structured the way that the employees who report data into the system wants. Furthermore, PM2 identified problems when exporting data from the systems, as there is a central unit that exports data who might not understand how the data is intended to be used. Again, us authors also share this experience and want to highlight that there is a risk of communication issues between the parties.

There is evident from the interviews that there is potential in Region Östergötland when it comes to data analyzing in Six Sigma projects. For it to be successful, however, the IT-systems that handles data collection and data exporting needs to be simplified to ensure that quality data is available for the projects.

7.3 Summary of CSF at Region Östergötland

When the case study at Region Östergötland was carried out, all 9 CSFs from the previous Case study at SkaS could be identified. In addition to these, the three critical success factors *Project Management Skills*, *Linking Six Sigma to Suppliers* and *Data Collection and It System* could be identified as a complement, unique for Region Östergötland (see Table 7).

Table 7 CSFs previously identified in Swedish healthcare compared with the results from the case study at Region Östergötland

Critical Success Factors	Identified in the Case Study at SkaS	Identified in the Case Study at Region Östergötland
Management Involvement and Commitment	X	X
Training, Education and Coaching	X	X
Linking Six Sigma to Business Strategy	X	X
Organizational Infrastructure	X	X
Project Prioritization and selection, Reviews, and Tracking	X	X
Linking Six Sigma to the Customer	X	X
Understanding the Six Sigma Methodology	X	X
Cultural Change	X	X
Communication	X	X
Project Management Skills		X
Linking Six Sigma to Suppliers		X
Data Collection and IT System		X

8. Development of a Six Sigma Implementation Plan within a Swedish Healthcare Context

In this chapter, the process of identifying what should be included in the implementation plan is presented. The findings in the literature study of how each CSF can be embedded in the Six Sigma initiative is presented. That was then further expanded upon in the development workshops at Region Östergötland. The result is a short concise list or process to ensure that each CSF is included in the implementation plan.

8.1 Management Involvement and Commitment

A summary of the findings in the literature study regarding how to ensure Management Involvement and Commitment is presented, followed by the main discoveries from the development workshops. The combined result of how to include the CSF in the implementation is then presented.

8.1.1 Theoretical and empirical findings

Ensuring the management involvement and commitment is the most frequently mentioned and often defined as the most important CSF, but how should it be achieved? Magnusson, et al., (2003) states that the first thing an organization needs to do is to educate the top management in Six Sigma. This approach was taken by SkaS when they started their Six Sigma initiative, which proved to be successful (Sveriges Kommuner och Landsting, 2008; Lifvergren, et al., 2010). Additionally, to secure management commitment over time a plan needs to be set for how the Six Sigma initiative should be implemented (Magnusson, et al., 2003). Together with the long-term plan, the top management also must decide on the scope for the Six Sigma implementation. Another key part of ensuring long-term involvement and commitment is to integrate the Six Sigma initiative with the established management operations, such as strategic business meetings (Cronemyr, 2007). An example of which meetings the management should attend is given in Figure 3 on page 19.

8.1.2 Development workshop

When the CSF was discussed at the workshop, the participants from Region Östergötland stated that to keep the management involved and committed throughout the Six Sigma initiative, Six Sigma must be included in the development strategy. They also stated that the support must be accessible and that this is preferably achieved by having a central unit responsible for the Six Sigma initiative.

8.1.3 Results

To ensure the managements involvement and commitment there are five factors that need to be included in the implementation:

1. Establish a central Six Sigma management team
2. Educate the top management
3. Establish a long-term plan
4. Determine the scope of implementation
5. Include Six Sigma in management meetings

8.2 Training, Education and Coaching

A summary of the findings in the literature study regarding how to train, educate, and coach in Six Sigma is presented, followed by the main discoveries from the development workshops. The combined result of how to include the CSF in the implementation is then presented.

8.1.2 Theoretical and empirical findings

Top Management

Magnusson, et al., (2003) believes that top management should be educated about what Six Sigma is, how it should be introduced and the importance of top management commitment in Six Sigma. The authors believe that the training should be between one and two days. Brue (2002) in turn mentions that the training program should start at the top with executives and managers.

Steering Committee (Champion/Sponsor)

Sörqvist & Höglund (2017) emphasize that the training to become a Sponsor can vary somewhat in structure and content. They further describe that a common design of the training consists of a two-day workshop. According to Sörqvist & Höglund (2017) the goal of the training is to give the people who have been appointed Sponsors an understanding of Six Sigma and how they should act in the improvement work.

Black Belt

Pyzdek & Keller (2010) claims that a Black Belt should receive 15-30 days of training in Six Sigma's technical tools. Sörqvist & Höglund (2017), on the other hand, states that the training should consist of a 20-day theoretical training part broken down into 4-8 blocks. Magnusson et, al., (2003) mention that the training program for the Black Belt role should be around 6 months with 13 to 17 days of seminars.

Both Sörqvist & Höglund (2017) and Magnusson, et al., (2003) claim that the theoretical part of the training should be carried out in parallel with the Six Sigma methodology being applied in sharp projects selected from their own organization. Chakhunashvili mentioned in his interview that SkaS also used a combination of practice and theory in the training of Black Belts and Green Belts. He further emphasizes that it was a successful approach to include projects in the education. The interviewee also mentioned that healthcare employees are

usually not accustomed to using statistical tools and techniques, which the training program helped them to achieve.

Magnusson, et al., (2003) state that Black Belts usually need to complete four in-course improvement projects to become a certified Black Belt. The authors consider that the goal of this approach is to ensure that the participants have understood the training and can use what they have learned to start generating cost savings at the company.

Lifvergren mentions in his interview that Black Belts have been trained differently at SkaS over the years; the first time with the support of a consultant, then internally, and currently at Chalmers University of Technology. The interviewee believes that the collaboration with different universities has worked well and thereby recommends that approach.

Green Belt

Brue (2015) emphasizes that Green Belts should be educated in the Six Sigma method with associated tools and have extensive knowledge of processes and products or services. Pyzdek & Keller (2010) claims that training for Green Belt should include quality management tools, project management, problem-solving, quality control tools, and data analysis. The authors also highlight that Black Belts usually support Green Belts throughout the training, assist in defining the projects and assist the projects after the training has ended.

Pyzdek & Keller (2010) proposes that the training to become a Green Belt should consist of a 5-day classroom training that is carried out in connection with Six Sigma projects. They also mention that a training of 10 days sometimes can be used to strengthen the knowledge of software skills. Magnusson, et al., (2003), on the other hand, claim that the Green Belt training should last for between 4-6 days. Sörqvist and Höglund (2017) describe that the training for Green Belt usually lasts between 5 to 8 days, but that both longer and shorter alternatives occur. The authors highlight that Green Belt is a local coordinator in improvement projects, which leads to that the meaning of the role varies greatly between different organizations.

Lifvergren explained in his interview that the Green Belts at SkaS received their education internally. As Chakhunashvili mentioned in his interview, Green Belts are trained in the same way as the Black Belts by alternating theory with real projects from the organization. Magnusson, et al., (2003) claim that employees usually need to complete one in-course improvement project to become a certified Green Belt.

Yellow Belt

Mashinini-Dlamini & van Waveren (2013) emphasizes that Green Belts and Yellow Belts are employees in the business who have undergone a Six Sigma training that entitles them to participate as project members in Six Sigma projects.

Brenig-Jones & Dowdall (2018) suggests that a Yellow Belt training should last for up to 2 days. Sörqvist & Höglund (2017), on the other hand, claim that a Yellow Belt training should last for 1 to 3 days.

Pande, et al., (2014) propose that the basic training in improvement methods and tools can be applied to simpler interventions with a small scope. The author also mentions that Yellow Belts tend to focus more on Lean-oriented methods rather than analytical variation-reducing skills. Sörqvist & Höglund (2017) also highlights that the training for Yellow Belt in larger organizations can be held as an e-course.

White Belt

Sörqvist & Höglund (2017) claim that the white Belt training consists of a short introduction to Six Sigma and its working methods. Brenig-Jones and Dowdall (2018) believes that White Belt training aims to create an awareness of Six Sigma. Sörqvist & Höglund (2017) also mentioned that people sometimes talk about awareness training when training White Belts.

Brenig-Jones and Dowdall (2018) claim that White Belt training should introduce the approach and most importantly the principles of Six Sigma to the employees. The author then describes that the training also exists to demystify the method and deal with some of the jargon that is part of Six Sigma. Sörqvist & Höglund (2017) emphasizes that large organizations sometimes offer the White Belt education as an e-course.

The training is regarding to Sörqvist & Höglund (2017) usually an information campaign aimed to all staff and consists of 2 to 4 hours. The content is adapted and depends entirely on the situation and intentions of the specific business. Brenig-Jones and Dowdall (2018), on the other hand, propose that the training to become White Belt can last from an hour up to a full day, depending on the organization's requirements. Magnusson, et al., (2003) emphasizes that the White Belt training usually consist of a one-day course that is offered to a broad layer of operators and front-line staff, in some companies to all employees.

8.2.2 Development workshop

Training and education were difficult to discuss at the workshops held at Region Östergötland. The group members agreed with the training plan that was presented and had no direct objections. The reason why it was difficult to get a response about the education plan may be due to the group's composition. How an educational program can be designed requires good insights and knowledge within both Six Sigma and Region Östergötland's strategy work. The workshop group composition may have made this success factor difficult to discuss.

One thing they pointed out during the workshop was the importance of the management receiving training to understand Six Sigma. They also highlighted that if a new top manager is recruited, they should have previous knowledge and experiences of Six Sigma, otherwise they should be trained immediately.

8.2.3 Results

Based on the analysis, a training program is proposed in Figure 13 below.

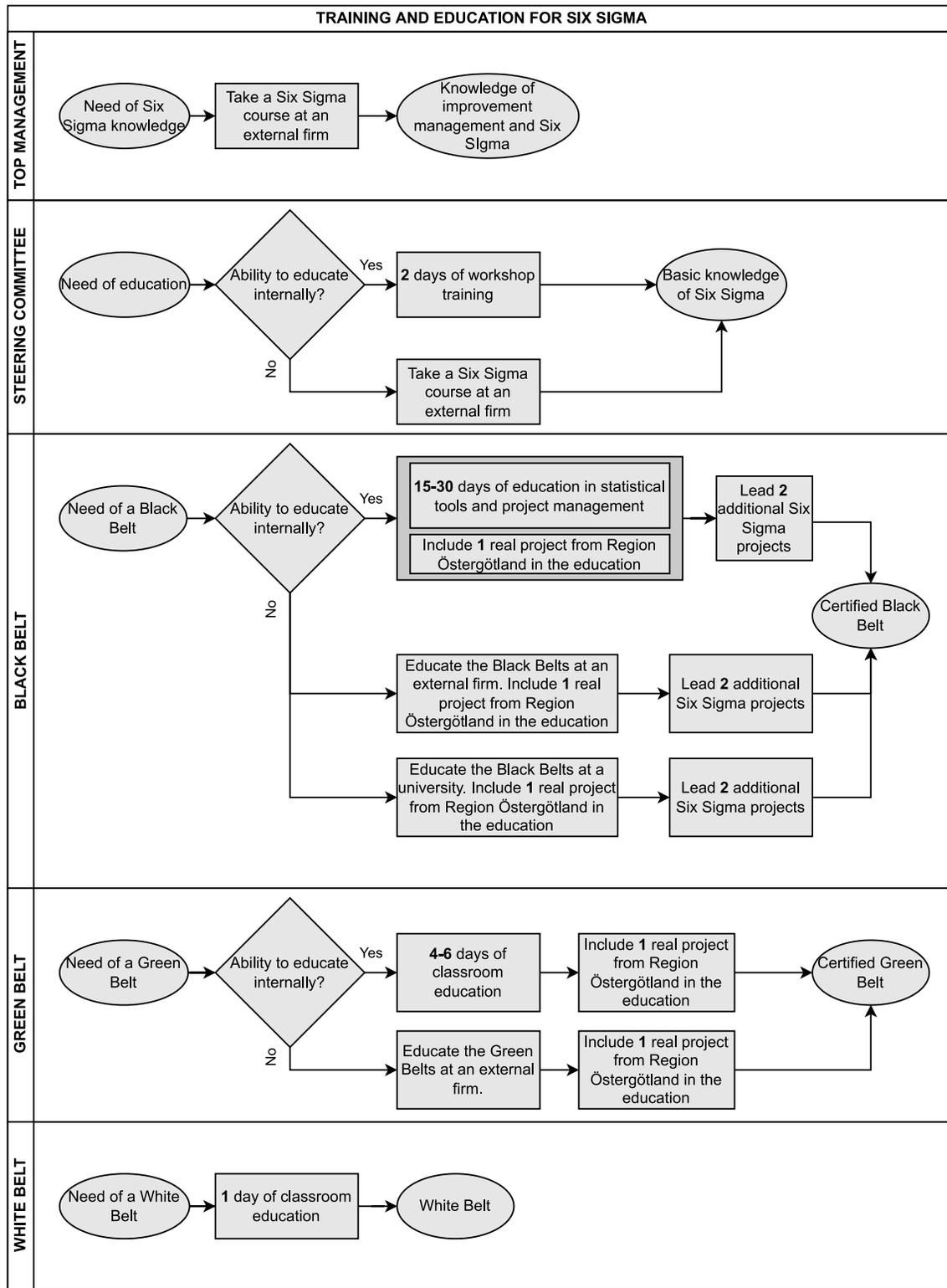


Figure 13 A proposed training program for how the different roles could be trained at Region Östergötland.

As can be seen in Figure 13, the Top Management should be trained externally as this factor is incredibly important to achieve a successful Six Sigma work. The ability to train the group internally is low and should therefore be done externally. It is important that training is provided again in cases where management is replaced.

For training of the Steering Committee, Black Belts and Green belts, different alternatives for training are proposed. If competence and resources is available internally, training should take place internally. If this is not the case, the training should instead take place externally. However, it will be the task of the Six Sigma management to make the final decision on whether the training of the various roles should take place internally or externally.

The people who are part of the Steering Committee (Champion/Sponsors) should be trained in a 2-day workshop. If there is ability and competence within the organization, we believe that this position can be trained internally. Otherwise, training should take place through an external company.

We primarily suggest that Black Belt should be trained externally as this training is more extensive. If education takes place externally, this should be done in collaboration with an external company or a university. Our proposal in this case is to strive to educate in collaboration with a university as this proved to work well when SkaS implemented Six Sigma. The Black Belt training should last between 15-30 days and include one real project from the organization. Once this has been completed, the employee can continue working as a Black Belt and lead two more projects to become a certified Black Belt.

Green Belts are easier to train internally as this training is not as advanced. Education should consist of about 5 days of education, which is in line with what the literature addresses. A real project from the organization should also be included in the training.

White Belt and Yellow Belt are mentioned in the literature as two different roles. We suggest that the two roles can be combined into one that includes basic knowledge about Six Sigma. This is because the literature is not consistent about what this role entails and whether both are needed or not. In addition to this, it also appears that SkaS did not use Yellow Belts but only White Belts. Education of White Belts and Yellow Belts should be seen as a way to impart basic knowledge about Six Sigma to a wide range of the organization. As a suggestion, the training should last for up to one day and should preferably be included in existing improvement training.

8.3 Linking Six Sigma to Business Strategy

A summary of the findings in the literature study regarding how to link Six Sigma to business strategy is presented, followed by the main discoveries from the development workshops. The combined result of how to include the CSF in the implementation is then presented.

8.3.1 Theoretical and empirical findings

Magnusson, et al., (2003) argue that the goals of every Six Sigma project should align with the overall goals of the organization. Cronemyr (2007) suggests that a way of linking Six Sigma to the business strategy is by having strategic meetings. The goal of the meetings should be to

identify the areas that are currently underperforming and find potential Six Sigma projects in the area identified.

Firka (2010) gives one example of a company that had a strong connection between the Six Sigma projects and the business strategy. The company used a top-down approach by using scorecards to identify potential projects. At SkaS the project selection had a different perspective than what it usually has in Six Sigma (Lifvergren, et al., 2010). The authors further describe that the projects were selected from KPIs that aimed to improve patient safety rather than reduce costs.

In the interview with PM2, it emerged that she thought that Six sigma should be linked to current methods used in the organization, to avoid the staff feeling that methods are constantly being replaced by new alternative methods.

During the project that the authors carried out at Region Östergötland, the financial savings that the project can provide were estimated. The savings were primarily based on shortened care time for patients and a reduced need for staff. However, because there was no standardized way of translating this into financial savings, the overall savings of the project was difficult to calculate.

8.3.2 Development workshop

When the results from the literature and empirics were presented during the workshop, the participants agreed that it is important to link Six Sigma with the business strategy. They further highlighted that successfully doing this link can be difficult as the organizations KPIs are hard to understand and concretize. While they stressed the importance of having this link, they had no further suggestions on how this should be done in practice.

8.3.3 Results

To ensure that the Six Sigma implementation is linked to the business strategy, the following things should be done:

- Select projects based on the organization's KPIs
- Include Six Sigma in the strategic meetings, preferably once a month
- Integrate Six Sigma with existing quality improvement work
- Integrate a model to calculate financial and quality gains

8.4 Project Prioritization and Selection, Reviews and Tracking

A summary of the findings in the literature study regarding how to prioritize and select Six Sigma projects and how to review and track them is presented, followed by the main discoveries from the development workshops. The combined result of how to include the CSF in the implementation is then presented.

8.4.1 Theoretical and empirical findings

Project Selection

Sörqvist & Höglund (2017) claim that an organization that works ambitiously with an improvement program such as Six Sigma should establish a systematic methodology for identifying and choosing which improvement projects to carry out. Figure 4 (Chapter 3.2.5) shows an example of what such a process might look like. The process at SKF includes a step called "review with filter questions". This step intends to make an initial selection of which projects are suitable to proceed as possible Six Sigma projects. The selection was done at SKF with help of the questions found in Figure 5 (chapter 3.2.5). The process (Figure 4) also includes a step to prioritize which projects that should be implemented and in which order. Sörqvist & Höglund (2017) suggest that projects should be selected based on both strategic and tactical factors. The authors also mentioned that the prioritization of projects is both complex and difficult to do. They further propose that a prioritization matrix can be used to simplify the prioritization of which projects are to be implemented and in which order (Figure 6). They provide an example where the projects are selected based on cost, customer effect, difficulty and spreadability.

Goldstein (2001), on the other hand, emphasizes that some of the aspects to take into consideration when selecting a Six Sigma project are the financial benefit, if data can be easily collected, if the project has a high probability of success, and can be completed within the given timeframe.

Cronemyr (2007) contributes an additional dimension that concerns which Six Sigma projects that should be selected. He suggests using an Effort-Effect diagram (Figure 7). Using the diagram, the projects with high complexity and high impact can be identified and selected as Six Sigma projects.

SkaS describes that the criteria for selecting projects should be seen as a CSF. They suggest that being more resource efficient, reducing overall healthcare costs, increasing patient satisfaction or safety, or improving the employee's work environment can be used to select projects (Sveriges Kommuner och Landsting, 2008). Chakhunashvili stated in his interview that the main adjustments made to make Six Sigma fit in healthcare were how the goals for the projects were set. The goals for Six Sigma are normally expressed in financial terms, however, Chakhunashvili explained that at SkaS the focus was not on how much money a project will save, but rather on healthcare quality and improvements. He stated that the financial savings that the project brought were considered a plus.

SkaS brought up something that was not mentioned in the literature studied in the frame of reference in this thesis. They mentioned that a project database for potential larger improvement projects was established with the intent that a new project is started as soon as a project leader is available (Sveriges Kommuner och Landsting, 2008). Lifvergren also stated in his interview that it is important to set up a project database where possible new Six Sigma projects can be stored. This facilitates new projects being started as soon as a project is completed.

Project reviews and tracking

Just as project selection is an important factor, project reviews are equally important (Antony & Banuelas, 2002). The authors further claim that by having the scheduled reviews, the possible barriers that hinder the project's progress can be highlighted and addressed. Cronemyr (2007) suggests that Six Sigma progress meetings should be held to ensure that the Six Sigma program is run as planned (Figure 3). For this meeting, he also gives an example in Figure 8 of a meeting agenda that can be used to ensure that the right people attend the meeting and that the right things are discussed. The article by Sveriges Kommuner och Landsting (2008) mentions that SkaS used tollgate after each phase to ensure that everything is completed, and that the project stays on track. It also keeps the sponsor, the project owner, and the rest of the steering committee informed of the progress throughout the course of the project.

8.4.2 Development workshop

The results from the literature and empirics were presented during the workshop. The participants suggested that the projects should be selected based on quadruple aim. Quadruple aim are some of the strategic goals that Region Östergötland works towards. At the same time, one of the participants pointed out that it is often difficult to work according to these goals and that they are unclear and difficult to understand. The participants further emphasized that great importance should be attached to choosing the right project as they are often relatively complicated and time-consuming.

During the workshop, the example found in the literature describing "filter questions" was presented (Figure 5). The participants suggested some small adjustments to the questions. They suggested to add questions about whether resources are available, if Six Sigma is suitable as a method, and whether the solution is known and determined with data.

The Effort-Effect diagram from the literature (Figure 7) was also presented during the workshop. The participants basically thought that the diagram was good but stated that it can be difficult to determine how complex a project is before it is started.

8.4.3 Results

Project Selection

Our first suggestion is that the project ideas should be collected and evaluated in a structured way in accordance with Figure 14 below.

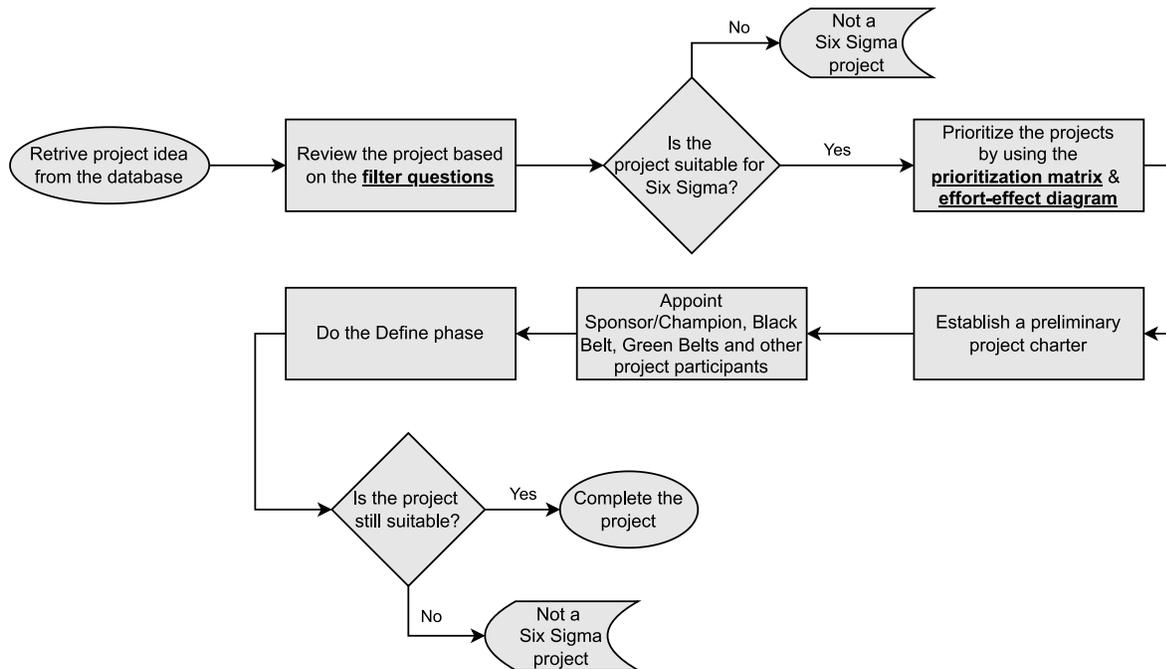


Figure 14 A process that Region Östergötland can use when selecting and prioritizing projects.

The process in Figure 14 is suggested since the literature addresses project prioritization and selection as an important factor and that Region Östergötland is missing a clear process for selecting improvement projects. The process is inspired from what Sörqvist & Höglund (2017) presented in their book, see Figure 4. Some changes were made for the process to better fit Region Östergötland. We choose to adjust the first step of the process so that it includes retrieving ideas from a database. The database is added as SkaS considered that it was an important part of their work to collect and select projects. The original process also included a process step for evaluating the project's risks. We claim that this step should instead be included in the newly added process step Define phase. Lastly, an extra step has been added after the Define phase where the project is again evaluated if it is suitable as a Six Sigma project.

The templates (underscoring in

Figure 14) that is suggested to be used for prioritizing and selecting Six Sigma projects are explained below.

Filter questions: In the process for selecting projects, there is a step containing filter questions. The filter questions are used to make a first screening of possible Six Sigma project. In this way, the ideas that are not suitable for the Six Sigma can be sorted out. Our proposal for what the filter questions should contain is presented in Figure 15 below. The proposal is based on what is addressed in the literature by Sörqvist & Höglund (2017), but is revised according to the views that emerged during the workshop with Region Östergötland.

Suggested Filter Questions Region Östergötland	
Is the solution known and based on facts?	No – Potential Six Sigma project Yes – Implement the solution
Is the root cause known with certainty?	No – Potential Six Sigma project Yes – Implement solutions that solve the root cause
Is the problem solved somewhere else?	No – Potential Six Sigma project Yes – Implement the solution of the previous project
Does the project affect at least one of the quadruple aim areas?	No – Not a Six Sigma project Yes – Potential Six Sigma project
Is there enough data available to quantify the problem?	No – Develop a data collection plan Yes – Potential Six Sigma projects

Figure 15 Filter questions that can be used to make a first selection of whether a project is suitable for the Six Sigma methodology or not. The filter questions are connected to the process in Figure 14.

Prioritization matrix: Another step in the process is to prioritize projects. We suggest that Region Östergötland should use a prioritization matrix like the one in Figure 16 below. The criteria found in the prioritization matrix are based on Quadruple aim, which the participants during the workshops took up as strategic goals that Region Östergötland works according to. The participants in the workshops at the same time emphasized that it is difficult to understand Region Östergötland's strategic goals. This leads to that it is difficult to prioritize among several possible projects. It is therefore important that the criteria used when prioritizing projects are easy to understand. If quadruple aim is not clear enough, these should be broken down into more detailed criteria that are easier to understand. In the prioritization matrix, weights are used to determine which factors are most important when selecting projects. It is also important that this prioritization is carried out by someone with extensive experience of prioritizing Six Sigma projects.

Criteria	Improved clinical experience	Improved patient experience	Lower cost of care	Better health outcomes	FINAL SCORE	RANK	SELECTED [X]
Weight	6	8	5	9			
Relative weight	0.21	0.29	0.18	0.32			
Project 1	5	6	10	2	5.2	3	
Project 2	2	5	8	1	3.6	4	
Project 3	3	4	7	9	5.9	2	
Project 4	3	4	7	10	6.3	1	X
Project ...	-	-	-	-	-	-	

Figure 16 Prioritization matrix to prioritize between several project ideas.

Effort-Effect diagram: We further suggest that the prioritization matrix in Figure 16 should be combined with the effort-effect diagram that Cronemyr (2021) presents in Figure 17. The prioritization matrix should first be used to obtain a final score that describes the effect of the projects. The score from the matrix should then be entered on the Y-axis in the effort-effect diagram shown in Figure 17 below. On the X-axis should the projects effort/complexity be considered. The projects with high effect and effort/complexity are potential suitable Six Sigma projects.

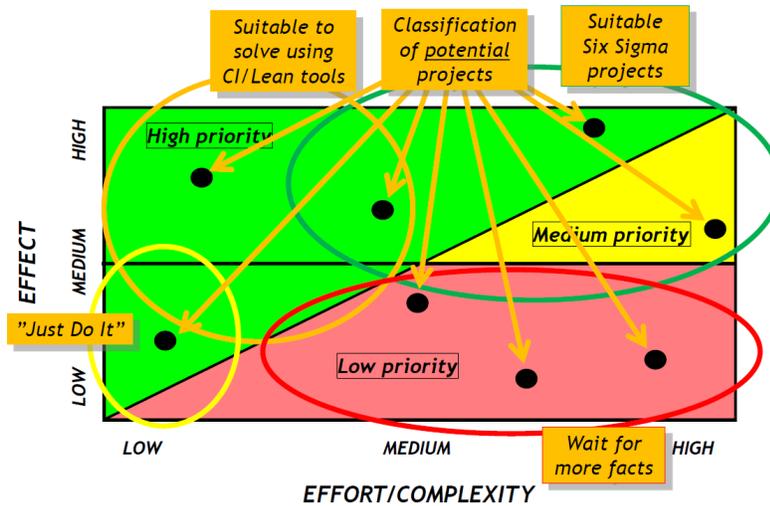


Figure 17 Effort-Effect diagram. Retrieved from (Cronemyr, 2021, p. 37).

Project reviews and tracking

Something that was addressed in the literature, in the case at SkaS and by Region Östergötland was the importance of following up projects. We propose two different processes and a meeting agenda to ensure that the projects are followed up both during the time they are up and running and after the solutions have been implemented.

Figure 18 presents the first process that should be used when the projects are up and running to ensure that they proceed as planned. In the Six Sigma projects there should be hard tollgates that checks if all tasks in the phase is completed. If not, a new tollgate is scheduled to check that the missing tasks are completed before moving on to the next phase.

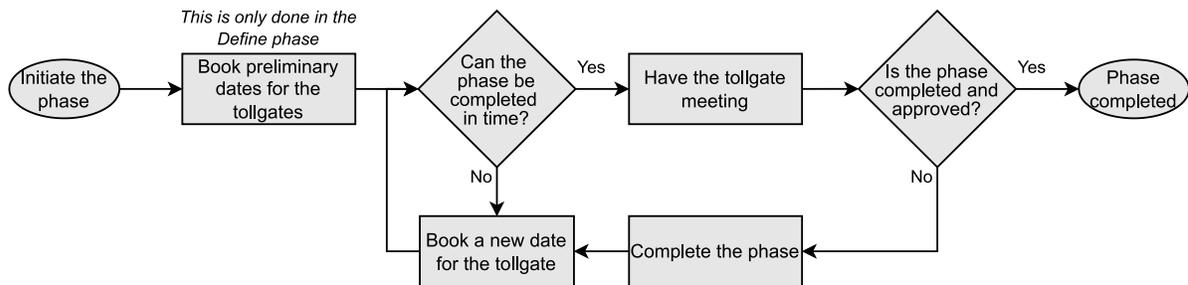


Figure 18 A process to ensure that tollgates are used during projects.

Figure 19 presents the second process that should be used after the solutions from the project have been implemented. The process intends to ensure that the results of the projects are followed up. If the implemented solutions do not meet the goals of the project, appropriate measures should be taken. The measures that are needed depends on how large the deviation from the goals is. Examples of appropriate measures could be adjusting the solutions, generating new solutions, and in worst case, redo the entire project.

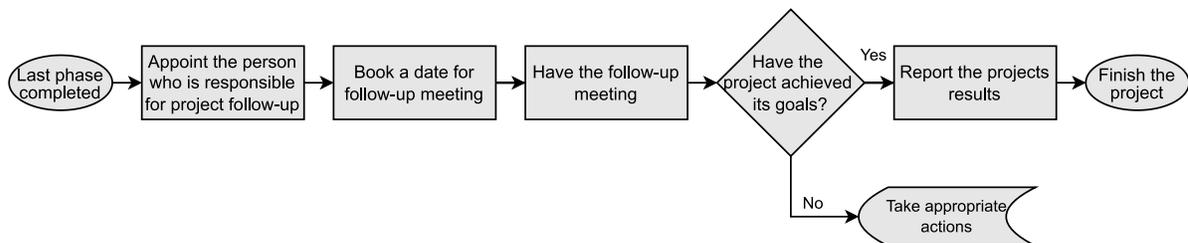


Figure 19 A process to ensure that the projects are followed up.

To further ensure that the projects are carried out as intended, we also suggest that meetings should be held once a month with an agenda in accordance with Figure 20. The meeting aims to discuss how the various Six Sigma projects are going.

Typical Agenda	Who
<i>Six Sigma STECO:</i>	
Six Sigma status in <i>sigma+</i>	SSPM
Black Belt Project Status Reports	BB:s/PO:s
Green Belt Project Status Reports	PO:s/(GB:s)
New Project Ideas	All
<i>Process STECO:</i>	
Reports from Process Teams (all processes)	PO:s
Other and Follow-up on last MoM	All
+ and Δ (Feed-back of the meeting)	All
<p><i>SSPM = Six Sigma Program Manager</i> <i>PO = Process Owner</i> <i>BB = Black Belt</i> <i>GB = Green Belt</i></p>	

Figure 20 Agenda for the Process & Six Sigma Steering Committee meeting at Siemens. Retrieved from (Cronemyr, 2007, p. A:29).

8.5 Organizational Infrastructure

A summary of the findings in the literature study regarding how a Six Sigma infrastructure should be organized is presented, followed by the main discoveries from the development workshops. The combined result of how to include the CSF in the implementation is then presented.

8.5.1 Theoretical and empirical findings

Champion/Sponsor: The champion or the sponsor for Six Sigma projects is usually a senior manager and is responsible for the projects results (Brue, 2002). It was found in the case study at SkaS that the main responsibilities for their champion/sponsor were providing the project to the Black Belt, taking key decisions in the project, and ensuring the projects progression (Sveriges Kommuner och Landsting, 2008). Also worth noting is that SkaS used the term Steering Committee for their champion/sponsor role which indicates that there was more than one person having this role in the projects.

Master Black Belt: A Master Black Belt is an individual who is highly skilled and experienced in the Six Sigma methodology (Brue, 2015). Master Black Belt is a full-time position and should be the most technically skilled in Six Sigma tools and preferably have the expertise to educate, train, and coach the Black Belts (Pyzdek & Keller, 2010). When an organization decides to implement Six Sigma, a Master Black Belt is best recruited from a consultancy firm (Voehl & Harrington, 2014), which is also what SkaS did. The Master Black Belt at SkaS was responsible for coaching and supporting the Black Belts. Furthermore, Chakhunashvili, who had the role of Master Black Belt, stated that having a technical background rather than a medical one was beneficial as he brought a unique set of skills to the table during the implementation process.

Black Belt: A Black Belt is normally a full-time position whose main task is leading Six Sigma projects (Voehl & Harrington, 2014). However, depending on the size of the Six Sigma organization, Black Belts can also take a more supporting role in the Six Sigma projects, coaching the Green Belts who now operate as project leaders (Kubiak, 2014). The findings in the literature study goes well in line with what was found in the SkaS case study. The Black Belts at SkaS were tasked with driving the progress of the projects forward (Sveriges Kommuner och Landsting, 2008). The key characteristics needed when leading the Six Sigma projects at SkaS were being driven, authoritative, analytical, and having a holistic view. It is worth noting that SkaS pointed out that they put more focus on involving the employees in the projects (Green Belts and White Belts), rather than having the Black Belt doing most of the work (Lifvergren, et al., 2010).

Green belt: A Green Belt is a part-time role that assist the Black Belts but can also lead their own smaller Six Sigma projects (Voehl & Harrington, 2014; Brue, 2015). When assisting Black Belts in the projects, the Green Belts can be seen as the worker bees in the project, helping with data analysis or experiments (Brue, 2015). When leading their own projects, the Green Belts have the same responsibilities as the Black Belts have when they lead projects. Green Belts was a part-time position at SkaS that took on the worker bee role in the larger Six Sigma projects (Sveriges Kommuner och Landsting, 2008). As mentioned in the Black Belt section, even if the Green Belts were “only” project participants they were still being involved a lot in the projects.

White belt: A White Belt is usually a front-line employee that participates in a Six Sigma project (Magnusson, et al., 2003). They need to have a basic understanding of the Six Sigma methodology and tools to be successful in their role. SkaS did not specify directly who the White Belts were or what role they had in the projects. Lifvergren did explain in his interview that nearly everyone at SkaS had a White Belt education. This, together with the note that SkaS focused on involving many employees, suggests that White Belts were widely participating in the Six Sigma projects.

Reference group: SkaS made an addition to their Six Sigma organization by adding a reference group (Sveriges Kommuner och Landsting, 2008). The reference group consisted of stakeholders, such as union representatives, that wants to be kept informed of the projects progress and provide insight if needed. In contrast of the Steering Committee at SkaS, the reference group did not play any part in decision-making in the projects.

Organizational structure

The organizational structure for Six Sigma can be designed in different ways. Below, in Figure 21, are three different organizational structures presented. Option A found in the literature and the organizational infrastructure that SkaS used for Six Sigma are the same but presented in different ways.

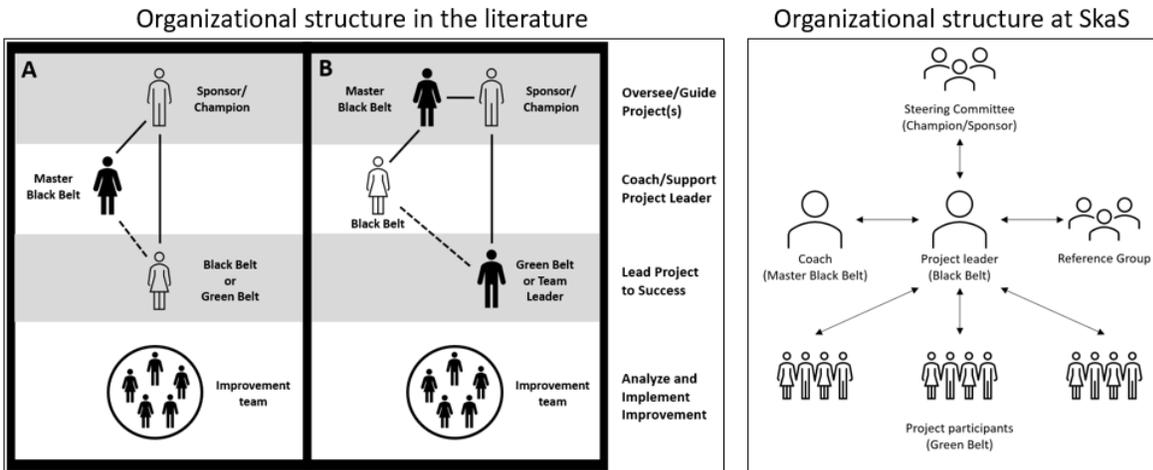


Figure 21. Two examples of how a Six Sigma organization can be structured. Retrieved from (Pande, et al., 2014, chpt. 8.1) and (Sveriges Kommuner och Landsting, 2008, p. 27).

8.5.2 Development workshop

The workshop participants provided insight on how they thought the Six Sigma organization should be structured. Mainly, they believed that having a centralized Six Sigma unit at Region Östergötland would be most efficient. When there is a problem identified in the operations that requires a Six Sigma project to solve, the centralized unit would then be called upon. The participants suggested that the Black Belts should be a part of this centralized unit. Black Belts would preferably be recruited among interested employees and current positions that would possibly fit the role are development managers and business developers. The Green Belts, however, were suggested to be a person that is both interested in the role and working more closely to the daily operations. Here, the local business developers could be used. For the White Belts in the projects, they should be recruited among interested employees at the unit where the project is located.

8.5.3 Result

We suggest that there should be two different Six Sigma project organizations, one for larger projects and one for smaller ones, see Figure 22. At the start of the Six Sigma initiative, when a lot of employees need training in the improvement method, we suggest using the organization for large projects. The reason for using the organizational structure for large project is because the Black Belts need training in leading projects. In the larger projects the Black Belt should act as the project leader with Green Belts and White Belts being in the improvement team and the Master Black Belt coaching and supporting the Black Belt when needed. In the smaller projects the Green Belt should be the project leaders with White Belts being in the improvement team and Black Belts coaching. Most importantly, the employees that are employed as Black Belts and Green Belts should be interested in the roles and eager to take on the challenge. The recruited employees must also have the characteristics that fit responsibilities for the Six Sigma role presented in Table 8 below.

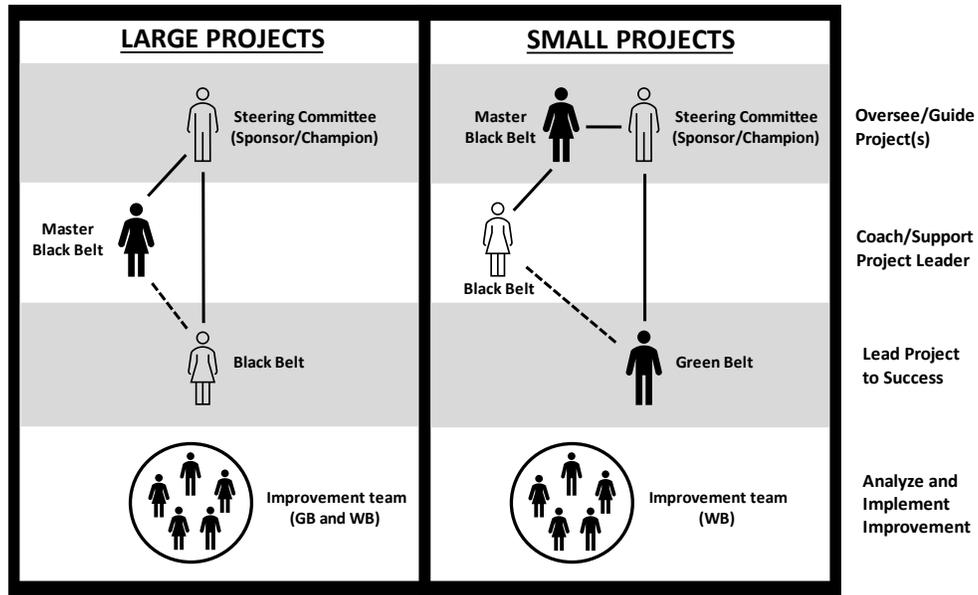


Figure 22. Suggested organizational structure for Region Östergötland to use in Six Sigma. Based on (Pande, et al., 2014, chpt. 8.1).

Table 8. A summary of the tasks that the Six Sigma roles are responsible for in the two different organizational structures A and B.

	Project size		Responsibilities
	Large	Small	
Oversee the projects	Champion / Sponsor	Champion / Sponsor	<ul style="list-style-type: none"> • The results of the projects • Establish a logic and a goal for business improvements • Be open to changes in the project definition and scope as the team collects data and deepens its analysis of the process • If necessary, support and approve changes to the team's charter and project scope • Ensure available resources such as time, support, and money for the team • Advocating for the team's efforts to the Six Sigma management team • Deal with ongoing disruptions that arise for the team when they encounter bureaucratic roadblocks • Collaborate with other managers to ensure smooth delivery of the team's solutions • To understand and absorb the importance of data-driven management and apply the lessons learned to their managerial job
Guide projects	MBB	MBB	<ul style="list-style-type: none"> • Educate and certify Black Belts and Green Belts • Identify and implement long-term Six Sigma projects • Communicate with Six Sigma management team and champions • Be able to break barriers for themselves instead of always relying on the champion/sponsor • Act as an evangelist - they need to have a strong drive for Six Sigma and spread the word. An important task in this is to be out on the firing line and meet and convert the naysayers
Coach & Support	MBB	BB	<ul style="list-style-type: none"> • Coach - be a contributor to the completion of projects. Promote team improvement by providing feedback, criticizing team effectiveness, and motivating and inspiring the team to succeed • Act in projects where Black Belts (A) or Green Belts (B) encounter difficulties defining root causes and implementing changes • Review and approve projects and project plans created by Black Belts (A) and Green Belts (B).
Lead the project	BB	GB	<ul style="list-style-type: none"> • Prepare, plan, and conduct team meetings with high efficiency • Lead the team through the defined Six Sigma process (DMAIC) • Maintain the project schedule and ensure efficient use of resources • Utilizing Six Sigma tools and methodologies • Execute and ensure that all action plans and project tasks are completed within the set time frame • Cultivating and maintaining political and organizational relations in parallel with communicating the team's progress to the Champion/Sponsor • Establish and maintain a continuing link to the champion/sponsor
Team members	GB	-	<ul style="list-style-type: none"> • Be involved in the project as worker bees • Assist in data analysis and experiments
	WB	WB	<ul style="list-style-type: none"> • Participate in specific project tasks • Knowledge contribution of the operations

8.6 Linking Six Sigma to the Customer

A summary of the findings in the literature study regarding how to link Six Sigma to the customer is presented, followed by the main discoveries from the development workshops. The combined result of how to include the CSF in the implementation is then presented.

8.6.1 Theoretical and empirical findings

Having a customer focus, or patient focus in this case, is a key part of Six Sigma and can be achieved by selecting projects from a patient perspective (Goldstein, 2001). The patient perspective should also be used in the projects when generating solutions (Antony, et al., 2007). In the case study at SkaS it was found that by being more process focused after implementing Six Sigma, they also became more patient focused (Sveriges Kommuner och Landsting, 2008). In the interviews with employees at Region Östergötland, PM2 stressed the importance of involving the patients in the projects directly, which was overlooked in the project she managed.

8.6.2 Development workshop

At the development workshops, the participants highlighted that Region Östergötland could be even more patient focused. When projects are selected there should be some parameters that focuses on the patient perspective. Furthermore, they wanted the Six Sigma training program to educate how the projects can and should be patient focused.

8.6.3 Result

Region Östergötland can link Six Sigma to the patient by:

- Focusing on the patient in project selection and solution generation
- Having the patient's perspective play a central part in the training program
- Including patients directly in the projects.

8.7 Understanding the Six Sigma Methodology, Tools, and Techniques

A summary of the findings in the literature study regarding understanding the Six Sigma methodology, tools, and techniques is presented, followed by the main discoveries from the development workshops. The combined result of how to include the CSF in the implementation is then presented.

8.7.1 Theoretical and empirical findings

For Region Östergötland to be successful in Six Sigma they need to have a thorough understanding of the Six Sigma methodology, tools, and techniques. Naturally, the understanding and knowledge of Six Sigma methodology, tools, and techniques is gained during a training and education program (Henderson & Evans, 2000). As more employees completes the training and education program the knowledge and understanding will organically grow within the organization. Lifvergren stated in his interview that with SkaS gaining more knowledge and experience from working with Six Sigma, they found an optimal methodology for their organization.

8.7.2 Development workshop

When this CSF was discussed at the workshops the consensus was that getting an understanding of Six Sigma and how to work with it is initially best achieved by establishing a training and education program. The experiences from the training program and working with Six Sigma should then be used to spread the knowledge within the organization.

8.7.3 Results

The two things needed to achieve this CSF is a training program and experience from working with Six Sigma. For more information about how the training program could be designed, see Figure 13.

8.8 Cultural Change

A summary of the findings in the literature study regarding how to change the culture in the organization is presented, followed by the main discoveries from the development workshops. The combined result of how to include the CSF in the implementation is then presented.

8.8.1 Literature and empiric findings

There are several different factors that play their part of achieving cultural change in an organization. Antony & Banuelas (2002) point to that motivation, communication, and education is needed at all levels. Firka (2010) identifies that cultural change grows from knowledge and experiences from working with Six Sigma. SkaS used guest lecturers as inspiration to change the culture of the organization (Sveriges Kommuner och Landsting, 2008).

The literature study together with SkaS's approach gives ideas of what could be done to change the culture within the organization. The interviews with the employees at Region Östergötland further highlights that the organization must actively work for cultural change. What is important to note is that simply implementing Six Sigma does not necessarily provide cultural change.

8.8.2 Development workshop

When presenting the findings from the literature and the empirical material the participants at the workshops agreed that cultural change is important and possible to achieve at Region Östergötland. The participants said that there is need of focusing on leadership, communication, and education, but wanted to further emphasize the importance of sharing experiences to inspire and motivate other parts of the organization.

8.8.3 Results

The management of the organization must continuously work towards achieving cultural change by focusing on the areas listed in Figure 23 below:

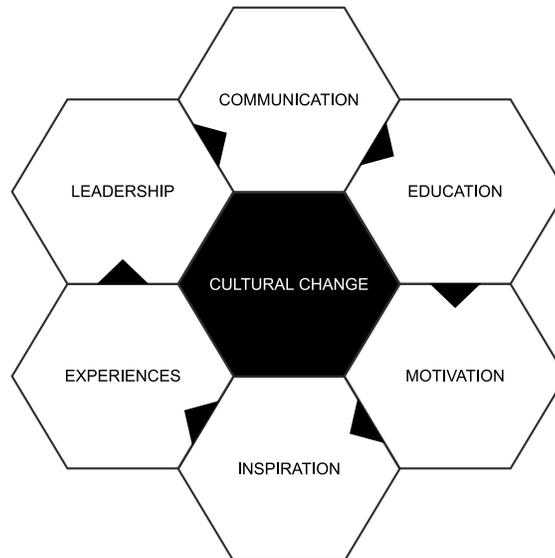


Figure 23 The six aspects that should be considered to reach a successful cultural change when implementing Six Sigma.

8.9 Communication

A summary of the findings in the literature study regarding how the communication of Six Sigma should be handled is presented, followed by the main discoveries from the development workshops. The combined result of how to include the CSF in the implementation is then presented.

8.9.1 Literature and empirical findings

SkaS identified that communication is important both for spreading the word of the Six Sigma implementation and throughout the run of the projects (Lifvergren, et al., 2010). The best way of ensuring that communication is handled correctly is to establish a communication plan (Pyzdek & Keller, 2010). The communication plan should include such information as the purpose of the communication, how it should be communicated, how often it will occur, and who is responsible for it.

8.9.2 Development workshop

The participants at the workshops stressed the importance of spreading the results from successful Six Sigma projects. For the employees to believe in Six Sigma they need to be given evidence from within the organization of the method being effective. Furthermore, they also pointed out that for Six Sigma to work at Region Östergötland the communication routes must be short and accessible.

8.9.3 Result

Two communication plans are needed, one for the Six Sigma program and one for the projects. Additionally, we suggest having a central unit for Six Sigma could simplify the communication routes. A suggestion of what to include in the communication plan for the Six Sigma program are presented in Table 9.

Table 9. A suggestion of a communication plan when implementing Six Sigma.

Purpose of communication	Channel of communication	Frequency of communication	Responsible of communication
To the Top Management			
Present Six Sigma program strategy, goals, and high-level program plan	• Top management training	• At the beginning of the program	• Six Sigma Management Team
Follow up Six Sigma program strategy, goals, and high-level program plan	• Strategic (KPI) meetings	• At least monthly	• Six Sigma Management Team
Present the results of the Six Sigma program	• Top management meetings	• At least monthly	• Six Sigma Management Team
To operational Employees at Region Östergötland			
Present how Six Sigma will be implemented	• Intranet • Newsletter	• At the beginning of the program	• Top Management • Six Sigma Management Team • Master Black Belt
Introduce/sell the Six Sigma methodology	• Training of employees • Intranet • Newsletter • Inspiration lecture	• At the beginning of the program	• Top Management • Six Sigma Management Team • Master Black Belt
Spread the results of the projects	• Intranet • Newsletter	• At least 2 times a year	• Top Management • Six Sigma Management Team • Master Black Belt

8.10 Linking Six Sigma to Suppliers

A summary of the findings in the literature study regarding how to link Six Sigma to suppliers is presented, followed by the main discoveries from the development workshops. The combined result of how to include the CSF in the implementation is then presented.

8.10.1 Theoretical and empirical findings

If the organization wants to take the Six Sigma implementation one step further, they can either involve the suppliers fully or just involve the suppliers in certain projects (Firka, 2010). There is, however, no evidence from the SkaS case that they involved suppliers in their Six Sigma initiative. Involving suppliers was brought up during the interviews with the Region Östergötland employees as a possibility, especially for data collection.

8.10.2 Development workshop

Involving suppliers in some specific projects were something that the participants at the workshops believed to be both possible and beneficial. A larger integration of suppliers in the Six Sigma implementation were however not something that they thought were needed.

8.10.3 Result

Involve suppliers in specific cases when it is needed for collecting data, but fully integrating the suppliers in the Six Sigma initiative is not required.

8.11 Data Collection & IT System

A summary of the findings in the literature study regarding how to collect data and use IT-systems in Six Sigma is presented, followed by the main discoveries from the development workshops. The combined result of how to include the CSF in the implementation is then presented.

8.11.1 Theoretical and empirical findings

During the interviews with the two employees at Region Östergötland, they emphasized the importance of data collection and the systems that enables it. Because there is a lot of data stored in different systems, that could become a problem when exporting and analyzing data in the Six Sigma projects.

8.11.2 Development workshop

When the potential problem of data availability was discussed at the workshops, they suggested that one way of mitigating the problem is to start the data collection early in the projects. During the project selection process, the availability of data should be taken into consideration. If there is a lack of data for the project, a data collection plan should be established.

8.11.3 Result

Check the availability of data early in the project selection and establish a data collection plan if needed. The data availability check is included in the filter questions in Figure 15.

9. Implementation Plan for Six Sigma within a Swedish Healthcare Context

In this chapter, the implementation plan will be presented. An explanation of all the steps, and their connection to the critical success factors, will be provided along with a tollgate checklist for each phase of the implementation plan.

9.1 Implementation Plan

Magnusson, et al., (2003) and Pyzdek & Keller (2010) each present an example of how an implementation plan for Six Sigma can be designed (see Figure 9 and Figure 10). The implementation plans do not specifically consider that the critical success factors are fulfilled. However, it is clear from the previous chapters of the thesis that the implementation of Six Sigma is an advanced process with many critical success factors to consider. The two implementation plans from the literature have therefore been further developed by including the results from the previous chapter 8, on what is required to fulfill the respective CSF. The further developed implementation plan can be found in Figure 24.

The implementation plan is divided into the four main stages: Planning & Alignment, Getting Started, First Wave of Six Sigma, and Second Wave of Six Sigma. Each sub-step found within the four main steps is explained in more detail below. In some sub-steps there are cross-references to processes, document templates, and figures from chapter 8. The connection to the results in chapter 8 is an important part of connecting the implementation plan with the critical success factors identified from the thesis literature study, empirical case studies and development workshops.

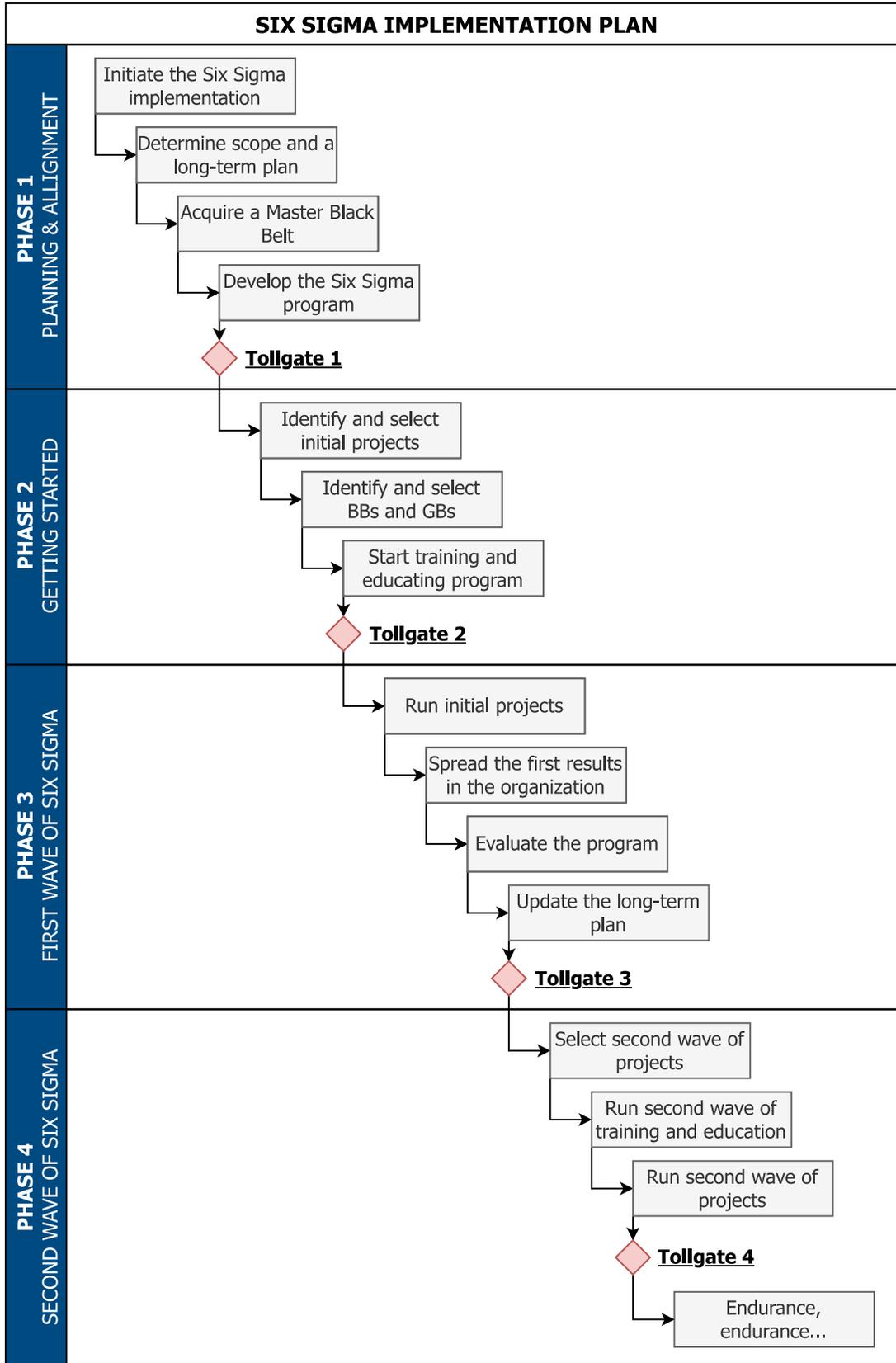


Figure 24 An implementation plan in 15 steps for how to implement Six Sigma within a Swedish healthcare context.

9.1.1 Phase 1 – Planning & Alignment

The first phase of the implementation plan focuses on initiating the Six Sigma implementation and creating a plan for how the implementation will be carried out. A further explanation of each step in the phase follows below.

Step 1.1: Initiate the Six Sigma implementation

The first thing that should be done in this step is to establish a Six Sigma management team. The team should consist of the managers responsible for the whole Six Sigma program and lead the implementation. When the Six Sigma management team has been established, they should take a Six Sigma course aimed specifically at managers to ensure that the team is committed to the cause. Provided that the management team are committed to Six Sigma, the next step is to spread the word to the rest of the organization that Six Sigma is going to be implemented and what Region Östergötland is hoping to gain by implementing it. The employees' initial reactions of the news could provide valuable insight of how the employees feel about the initiative and the implementation can be tweaked based on these reactions. After the initial communication, the Six Sigma management teams should start the processes of finding potential Six Sigma projects and interested employees for the Black Belt and Green Belt roles.

Step 1.2: Determine scope and a long-term plan

The next step for the Six Sigma management team is to determine the scope of the implementation and a long-term plan for Six Sigma. It is important that the goals of the whole Six Sigma initiative are connected to the overall business strategy of Region Östergötland. When determining the scope of the implementation it is important to include how many projects should be completed and how many Black Belts and Green Belts the organization needs. This is to facilitate the right resources being available when the first wave of projects and training is started. To give an idea of the scopes size, SkaS who has roughly half the amount of care places as Region Östergötland started with seven projects.

Step 1.3: Acquire Master Black Belt

With the scope determined and the long-term plan established, the next step for the Six Sigma management team is to acquire a Master Black Belt. Unfortunately, a Master Black Belt is hard to find within the organization and we do not recommend training one either. A Master Black Belt should have extensive experience from Six Sigma, which cannot be gained simply from a training program. Instead, we recommend one of two options: use a consultancy firm or hire a Master Black Belt. Worth noting is that the Master Black Belt does not necessarily need to have a background in the medical field and could be found in other fields.

Step 1.4: Develop the Six Sigma program

The Six Sigma management team together with the Master Black Belt should then establish an organizational infrastructure for Six Sigma. A suggestion of how the Six Sigma organizational infrastructure can be structured is presented in Figure 22. After the organizational infrastructure is defined, the team must decide upon how the employees should be trained and educated in Six Sigma. There are a few different ways the training could be done which are presented in Figure 13. Next up is setting up a database for gathering project ideas. This is something that becomes more important as time goes on and the number of project ideas

increases, but we recommend setting up the database right away. Having the database up and running make it easy for the different healthcare units to submit their project ideas. The Six Sigma management team must also set up meetings to secure the commitment over time. A suggestion of which meetings could be held is presented in Figure 3.

Tollgate 1

At the end of each phase, a tollgate should be carried out to ensure that all steps in the phase are achieved as intended. A checklist of questions that should be checked in the tollgate is found in Table 10 below. All steps in the checklist must be completed before the next phase can begin.

Table 10 A checklist with questions that should be used in the first tollgate to ensure that all necessary steps are completed within the first phase.

Phase 1: Tollgate 1
Step 1.1 – Initiate the Six Sigma implementation
<input type="checkbox"/> A Six Sigma Management team for the initiative has been established
<input type="checkbox"/> The management has been trained in the Six Sigma method
<input type="checkbox"/> That Six Sigma will be implemented has been communicated to the organization
<input type="checkbox"/> A process has been initiated to find suitable Six Sigma projects and interested employees
Step 1.2 – Determine scope and a long-term plan
<input type="checkbox"/> The goals of the Six Sigma initiative are connected to the overall business strategy
<input type="checkbox"/> Decide how many projects to carry out during the first wave of projects
<input type="checkbox"/> Decide how many Black Belt and Green Belts that is needed during the first wave of projects
Step 1.3 – Acquire Master Black Belt
<input type="checkbox"/> A Master Black Belt has been appointed through an employment or an external consulting firm
Step 1.4 – Develop the Six Sigma program
<input type="checkbox"/> An infrastructure with clear roles and responsibilities has been established
<input type="checkbox"/> A training program for how the roles are to be trained has been established
<input type="checkbox"/> A process to create a database where project ideas can be collected has been initiated
<input type="checkbox"/> The Six Sigma Management Team has established a meeting program to ensure their commitment over time

9.1.2 Phase 2 – Getting Started

In the second phase, suitable projects and employees are selected and the training program begins. A further explanation of each step in the phase follows below.

Step 2.1: Identify and select initial projects

The first step in the second phase is to select a first round of projects. The projects selected should be of such a nature that they are relatively easy to carry out and probably provide good returns. The probability that the projects will achieve a successful result should be high. The first projects that are implemented should therefore not be too complex. The reason for this is to ensure that the projects can be completed on time and that their good results can be disseminated to the organization.

We have created a process for how projects should be selected that we believe may be suitable for Region Östergötland to use. The suggestion can be found in its entirety in chapter 8.4.3. In summary, projects should be selected based on the overall strategic objectives, complexity, and potential benefits.

Step 2.2: Identify BBs and GBs

The next step in the second phase is to identify and select employees from the organization who are interested and suitable to be Black Belts and Green Belts. It is important to find employees who themselves want to participate in the Six Sigma initiative as the inner drive is important to create a good culture of improvement. The employees who are selected should also possess the right basic skills in order to be able to fulfill the role in the right way. Information on what basic competencies that is needed for each belt role and how the different roles should be organized can be found in its entirety in chapter 8.5.3.

Step 2.3: Start training and education program

After BBs and GBs have been identified and selected, these should be trained to gain solid knowledge of the Six Sigma method. The training for each belt role varies depending on the degree of competence they need. The training should be conducted in accordance with the Six Sigma program established in Step 1.4- Develop the Six Sigma program.

Step 2.4: Tollgate 2

A checklist of questions that should be checked in the tollgate is found in Table 11. All steps in the checklist must be completed before the next phase can begin.

Table 11 A checklist with questions that should be used in the second tollgate to ensure that all necessary steps are completed within the second phase.

Phase 2: Tollgate 2
2.1 – Identify and select initial projects
<input type="checkbox"/> A standardized process for how Six Sigma projects should be selected has been implemented
<input type="checkbox"/> Projects have been selected for the first wave
2.2 – Identify BBs and GBs
<input type="checkbox"/> Interested employees suitable for the roles as Black Belts or Green Belts have been selected
2.3 – Start training and education program
<input type="checkbox"/> The training program has been started in accordance with step 1.4 in Phase 1.

9.1.3 Phase 3 – First Wave of Six Sigma Projects

In the third phase, the first wave of Six Sigma projects is carried out and the first results from these are disseminated in the organization. The projects are then evaluated to make it possible to take relevant actions to improve the areas that did not go as planned in the second phase. A further explanation of each step in the phase follows below.

Step 3.1: Run initial projects

Step one in the third phase is to start the first wave of Six Sigma projects. As we mentioned in step 2.1- Identify and select initial projects, it is important that the projects that are started are selected with the requirement to have a good probability of achieving a successful result. During the project, tollgates should be held after each phase. This should be done to ensure that the projects are run as intended and achieve their set goals. We suggest that Region Östergötland uses a clear process for how and when the tollgates should be held. The process we propose is found in its entirety in Figure 18.

Step: 3.2 Spread the first results in the organization

When the first results have been collected from the projects, its results should be communicated to the employees. Communicating the results is important from several points of view. First, it is important to show employees that the method works. Secondly, it is important to inspire more employees to want to be part of the Six Sigma initiative. By communicating the results, the culture around the improvement work can change. In summary, it can be said that it is important in the long term to change the culture in the organization so that the employees want to work according to the method.

Step 3.3: Evaluate the program

When the first results have been collected and communicated to the employees, the first wave of the Six Sigma program should be evaluated. The purpose of this is to correct for what did not work as intended. Examples of areas that should be reviewed are:

- If the projects could be run as intended
- If the training worked well
- If the organization has been appropriate
- If the communication within the project and to other employees worked well
- If a change in culture begins to be seen in the organization
- If the selection of projects worked as intended
- If the management has been involved and committed to the Six Sigma initiative

A good way to identify correct for what did not work as intended is to study the projects that have not reached their goals. Once the root causes of the failed projects have been identified, appropriate action can be taken. Examples of measures that can be taken are, change existing processes, revise the training program, or change the criteria for selecting projects.

Step 3.4: Update the long-term plan

The last step in the third phase is to update the long-term plan. The plan should be updated after the management has become more experienced with Six Sigma as an improvement method. The update should be based on management's experience from the projects completed. At this point, it is easier for the management to specify more detailed goals and dare to set more challenging performance goals for the initiative.

Step 3.5: Tollgate 3

A checklist of questions that should be checked in the tollgate is found in Table 12. All steps in the checklist must be completed before the next phase can begin.

Table 12 A checklist with questions that should be used in the third tollgate to ensure that all necessary steps are completed within the third phase.

Phase 3: Tollgate 3
3.1 – Run initial projects
<input type="checkbox"/> A process for how tollgates should be performed after each phase has been implemented
<input type="checkbox"/> The first wave of projects with a high probability of success has been started
3.2 – Spread the first results in the organization
<input type="checkbox"/> The results from the successful projects have been communicated to the organization's employees
3.3 – Evaluate the program
<input type="checkbox"/> The projects that did not reach their results have been studied to determine why they failed
<input type="checkbox"/> The entire Six Sigma program has been evaluated to identify what did not go as planned (including training programs, templates, processes, etc.)
3.4 – Update the long-term plan
<input type="checkbox"/> The long-term plan has been updated

9.1.4 Phase 4 – Continuous Six Sigma Work

The last and fourth phase is about creating conditions for a long-term Six Sigma work. In the phase, the second wave of projects and training is started. A further explanation of each step in the phase follows below.

Step 4.1: Select second wave of projects

In phase four, it is time to start another wave of Six Sigma projects. Before selecting the new Six Sigma projects, the results of the first projects need to be evaluated. This evaluation is done to identify possible flaws in the project selection process. If there are some projects from the first wave that are unsuccessful, an understanding of why they were unsuccessful can be used to improve the project selection process. When this is done the projects for the second wave should be selected the same way as in the first wave.

Step 4.2: Run second wave of training and education

Here, new employees should be included in the training program. The point of including new employees is to further spread the knowledge and competence in the organization. The employees that completed their training in the first wave could and should work with other improvement projects outside of the training program.

Step 4.3: Run second wave of projects

This step is self-explanatory. The second wave of projects are to be ran the same way as in the first wave.

Step 4.4: Tollgate 4

A checklist of questions that should be checked in the tollgate is found in Table 13 below. All steps in the checklist must be completed before the next phase can begin.

Table 13 A checklist with questions that should be used in the fourth tollgate to ensure that all necessary steps are completed within the fourth phase.

Phase 4: Tollgate 4
4.1 – Select second wave of projects
<input type="checkbox"/> An evaluation of the project selection process from the first wave has been carried out
<input type="checkbox"/> The project selection process has been updated based on the experience from the first wave
4.2 – Run second wave of training and education
<input type="checkbox"/> The second wave of the training and education program has been started
4.3 – Run second wave of projects
<input type="checkbox"/> The second wave of projects has been started

Step 4.5: Endurance, endurance...

Long sustaining results does not come easy. The Six Sigma management team must keep being committed to the initiative and push for Six Sigma to spread further in the organization. The Black Belts must be given support to find new areas in the organization that they can improve. One way of spreading the Six Sigma initiative is to start involving suppliers on a larger scale. In short, for Six Sigma to be successful in the long run the organization must show endurance.

10. Conclusion & Discussion

In this chapter, the conclusion for each research question is first presented, followed by a method and result discussion. Finally, proposals for future research and a summary of the thesis main contributions are presented.

10.1 Summary of the Research Questions' Results

Below is a conclusion presented for each research question.

RQ1- What critical success factors are required for a successful implementation of Six Sigma within a Swedish healthcare context?

The following 9 points should be seen as critical success factors when implementing Six Sigma within a Swedish healthcare context:

1. Management Involvement and Commitment
2. Training, Education, and Coaching
3. Linking Six Sigma to Business Strategy
4. Organizational Infrastructure
5. Project Prioritization and Selection, Review, and Tracking
6. Linking Six Sigma to the Customer
7. Understanding the Six Sigma Methodology
8. Cultural Change
9. Communication

RQ2- What critical success factors have Region Östergötland identified as necessary, based on their experiences from previous Six Sigma projects?

The following 11 points should be seen as critical success factors when implementing Six Sigma at Region Östergötland:

1. Management Involvement and Commitment
2. Training, Education, and Coaching
3. Linking Six Sigma to Business Strategy
4. Organizational Infrastructure
5. Project Prioritization and Selection, Review, and Tracking
6. Linking Six Sigma to the Customer
7. Understanding the Six Sigma Methodology
8. Cultural Change
9. Communication
10. Project Management Skills
11. Linking Six Sigma to Suppliers
12. Data Collection & IT system

RQ3- How should an implementation plan look like when implementing Six Sigma at Region Östergötland?

An implementation plan for Six Sigma is presented in Figure 25. A thorough explanation of each step in the implementation plan is provided in the previous chapter.

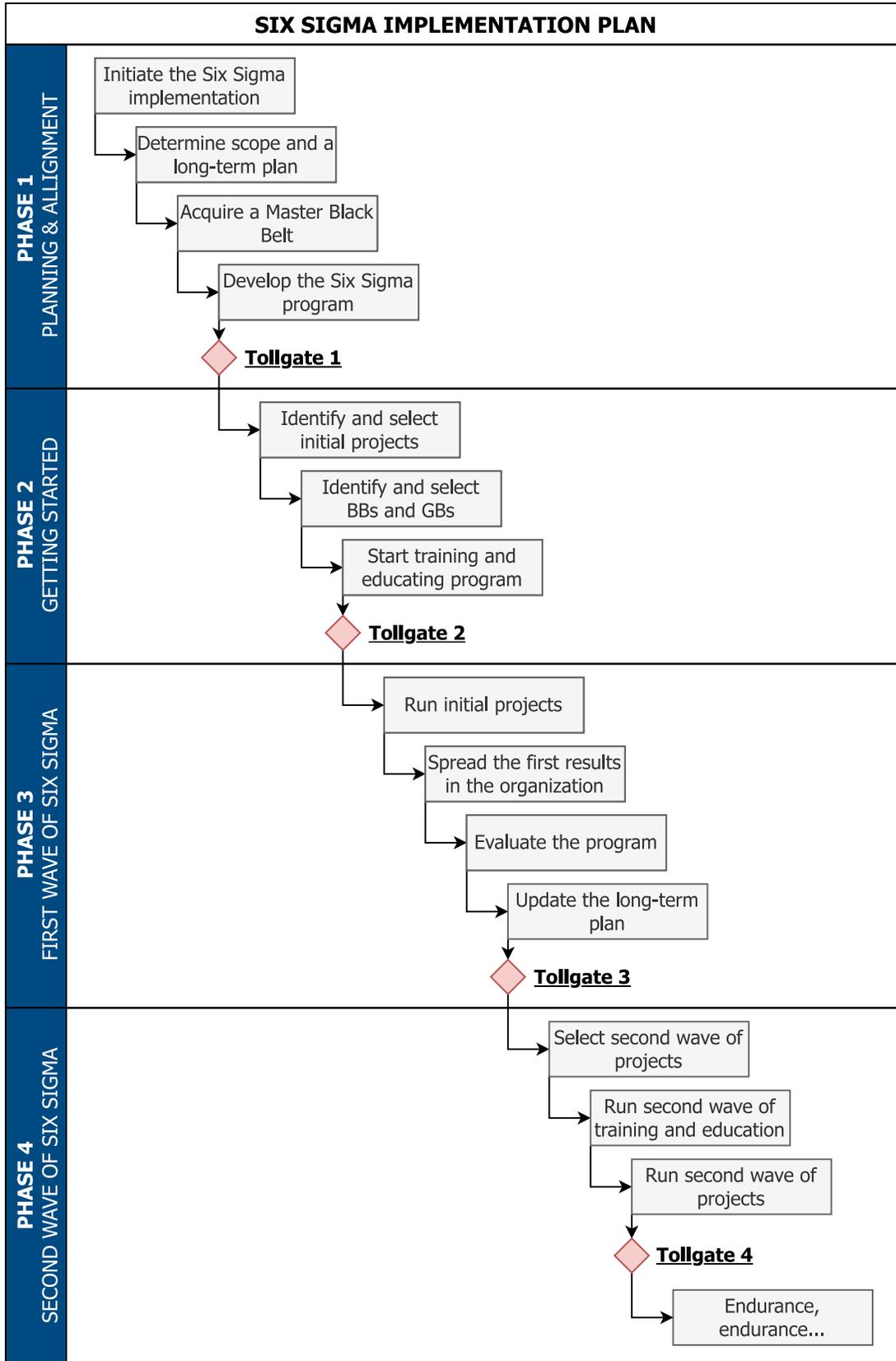


Figure 25 The same Implementation Plan as previously presented in Figure 24.

10.2 Method discussion

The method used in this thesis was chosen because it was believed that it would generate useful end results for the research questions. To that end, the method is considered to achieve its purpose. The two case studies that was carried out were relevant and needed to lay the foundation for the implementation plan. Using Sweden's first, and the only well-documented, implementation of Six Sigma in a healthcare context was of great value to gain insight into how the improvement method could be adapted in Swedish healthcare. Because the case already was well-documented there was no issues of getting an understanding of how they managed their implementation process and what they achieved by it. The interviews then worked as a tool for filling in the gaps and gain more information about certain parts of their implementation. By then following up the first case study with another one specifically aimed to compare the finding in the literature and the first case study with the experiences at Region Östergötland. The second case study came naturally as Region Östergötland was the client of the thesis and us authors had previous experience working with Region Östergötland. Using this methodology was considered successful as it enabled the implementation plan to be constructed by combining three different perspectives: the theoretical perspective, Swedish healthcare perspective, and the own organizations perspective.

Using semi-structured interviews in both case studies was beneficial as it opened up for the interviewees to add other information that otherwise might have been overlooked. The interview method also enables us interviewers to act on the fly and add follow-up questions when it was considered necessary. Furthermore, the interviewees were chosen with the intention of gaining insight from people with different experiences. This is something that the authors believe was done successfully, especially in the first case study where the two interviewees both were a part of the implementation process but with different responsibilities. Perhaps it would be beneficial to also interview someone at SkaS with a more operational role in their Six Sigma implementation, such as a project manager, to get a more holistic view. Due to the time limit, however, it was decided to put more focus towards the implementation part of Six Sigma rather than specific project operation. In the second case study there were fewer candidates to choose from which led to the decision of interviewing those with the most firsthand experiences of Six Sigma being made.

Even though the validity of the interviews were strengthened by recording, reviewing, and sending the summarization back to the interviewee for fact-checking, there could had been more focus on the reliability of the results further. Yin (2018) claims that the reliability of the data tends to change in a qualitative study because the environment, setting and time may affect the result. One way of increasing the reliability could have been to include all interview questions and answers in the thesis, not just the interview guides. That would have made it easier to get the same results for someone trying to replicate the work. However, because of the semi-structured way of conducting the interviews it was considered more natural to solely provide the interview guides, since that was the starting point of the interviews.

10.3 Results discussion

The findings in the literature study and the first case study were very similar. One reason to the similarity might be due to the nature of what was looked for, namely critical success factors. For the Six Sigma implementation at SkaS to be successful, the CSF should have to be considered beforehand and included in the implementation. Since it was found that the implementation at SkaS were successful, there is no surprise that the CSF at SkaS were very similar to those in the literature. Henderson & Evans (2000, p. 269) state that *“There are several key elements that are necessary for successfully implementing Six Sigma...”*, which cements the narrative that for SkaS to be successful the factors had to be present. To further add to this point, one of the authors of the book *Six Sigma: The Pragmatic Approach* also had a part in the implementation at SkaS. This could explain why their implementation goes in line with what was found in the literature study.

For the second research question there could be argued that the empirical data collected, the interviews and observations, are a bit thin, and with it being a bit thin, the results unreliable. There are, however, an explanation for this. Region Östergötland had, unfortunately, only carried out three Six Sigma projects at the time of this thesis. Other improvement initiatives at Region Östergötland could possibly have been analyzed to better understand how they usually work in this area, but that was considered outside of the scope of the thesis. Additionally, the results being in line with what was found in both the literature study and the first case strengthens the reliability of the results.

Breaking down all the CSF into actions or processes to create an implementation plan was more difficult than expected. It was easy to extract which CSF were important and why from the literature study, but it was often not specified exactly how said CSF could be attained. But after a deeper dive into the literature all the CSF could be deconstructed into smaller pieces of how they could be attained, often into actions and processes. Using these actions and processes as a basis for the implementation plan worked well. Having this basis, it became easy to ensure that all the CSF were included in the implementation plan. It was a good way of tying it all together in the end.

10.4 Future Research

To further expand upon Six Sigma in a healthcare context, we suggest that the following topics could be investigated:

- Verify the results of the thesis by studying the implementation of Six Sigma at Region Östergötland or another Swedish healthcare organization, granted that they use the suggested Six Sigma implementation plan.
- Perform a follow-up case study at SkaS to see how Six Sigma has developed at the organization and how the methodology has integrated into the daily activities. The results of the case study can provide valuable insight into how, and if, Six Sigma can be an improvement method in Swedish healthcare that is sustainable in the long run.

- The literature often mentions which CSFs are important in the implementation of Six Sigma. However, there is a gap in the literature regarding practical actions of how to fulfill and ensure that the CSF are included in the implementation process. Organizations that have successfully implemented Six Sigma should be studied to identify the actions that the organization has taken to ensure that the CSFs are included in the implementation.

10.5 Main Contributions

The following points are considered to be the thesis main contributions:

- In the literature studied, no studies were found that focused on investigate which CSFs that are important when implementing Six Sigma within a Swedish healthcare context. This information can therefore be considered a contribution to the literature and is answered in Research Question 1.
- In the literature studied, there was insufficient information about the connection between proposed implementation plans for Six Sigma and CSFs. Research Question 3 can therefore be considered a contribution to the literature as an implementation plan is presented that also includes what should be considered from each CSF.
- There is only one case in the literature where Six Sigma has been implemented in Swedish healthcare. This implementation was done at SkaS where the material found is spread across various articles and documents. This thesis can therefore also be considered to contribute by compiling the material that exists around the SkaS case into a coherent text.

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Appendix 1 Interview Guide- Svante Lifvergren

- Who are you / where do you currently work / what do you work with?
- What was your role in the implementation of Six Sigma?
- How has the work with Six Sigma proceeded? Has it continued to go well? Is Six Sigma used to the same extent today? Has anything significant changed in the working method / organization from what is stated in Lifvergren's documentation / literature?
- Is there anything you feel you missed during the implementation? Was there anything you should have done differently to become even more successful?
- What are the biggest obstacles to implementing Six Sigma in a healthcare context?
- Do you think that the implementation was done to a reasonable extent? With a reasonable "pace"?
- Do you think other hospitals should invest in Six Sigma or are there other methods that you think would have worked better?
- In the report, you specified 5 success factors, have you found any more over time that have been important?
- How did you do with Master Black Belt from the beginning? Did you use a consultant?
- How did the collaboration with the University go? Why did you choose to train staff through this collaboration?
- Do you think that a future collaboration between Ska and Region Östergötland may be possible to link lessons from previous implementation? How?

Appendix 2 Interview guide- Alexandre Chakhunashvili

- At what stage were you recruited as a Master Black Belt? Was it early in the implementation or after a certain time?
- Do you know the concept of CSF within Six Sigma? What success factors could you identify at SkaS?
- What do you think went well with the implementation of Six Sigma on SkaS?
- What were the challenges with the implementation?
- Would you have done something different if you had the opportunity to do it again?
- Was it difficult to train the staff around statistical tools? How was their previous experience with statistical tools?
- How would you describe the culture in healthcare? Open to change? Do as you have always done?
- How was the organization around you designed? With belts etc.
- Is Six Sigma suitable for healthcare?

Appendix 3 Interview Guide- PM1 and PM2

Questions about existing improvement work at Region Östergötland:

- How are improvement projects selected at present?
- How would you describe the culture in healthcare?
- What support does the organization currently have for collecting and analyzing data?
- What factors do you think are the most important to be successful in Six Sigma work?
- How do you follow up the results from the improvement projects you are currently doing? How is it ensured that the results are integrated into the operation?
- How often do you currently use statistical tools in improvement work? What would it have meant to you who work with improvement work if you received training in statistical tools?
- How is knowledge disseminated within the organization? How can employees take part in the goals that are set?

Questions about previously completed Six Sigma projects at Region Östergötland:

- How did the work with the Six Sigma project work? What worked well? What worked poorly?
- How do you think the management's control of the project worked? Were they involved in the project? Did they show commitment?
- What training and coaching do you think you would need to undergo to be able to run the operational work of a Six Sigma project on your own?
- How do you think Six Sigma could be linked to current strategies for improvement work (eg lean)?
- If you were to run your own Six Sigma projects at GAVA, how do you think the organization could be structured?
- How did you work in the project with a patient focus? Was this discussed in the project? Did it differ somewhat from the daily work with existing methods?