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Possibilities and Challenges in Combining Six Sigma and Continuous Improvements

Master of Science Thesis

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ABSTRACT

This study aims to explore how Six Sigma can be related to continuous improvement work at a manufacturing plant, as well as to understand challenges and possibilities in using Six Sigma as a part of a continuous improvement initiative. This is done by focusing on the problems of what ways Six Sigma and continuous improvement initiatives can be linked, and how Six Sigma can be continuously improved. The theory has its focus on Quality Management, Continuous Improvements and Six Sigma, and the material is based on company documents, academic literature, interview notes as well as notes from observations. The data is collected from observations, interviews and literature study. The study gives several examples of how Six Sigma and Continuous Improvements both strengthens and weakens each other, where a structure both can work negative or positive for Continuous improvements. Creating concrete goals and commitment works mutual between the methods. Reducing cost can increase resource allocation and a common language can increase speed of improvement implementations and strengthening a weak foundation.

It is important to know the true reason for why an organization uses Six Sigma. And to improve the use of Six Sigma the responsibility for the method have to be spread over the whole organization as well as there has to be strive toward creating a coherent view of Six Sigma within the organization. There should always be the best suited employees working with and there has to exist resources allocated for coaching the belts. It is suggested lessons learned is something that is beneficial to improve and that Continuous Improvements that cost more resources than the benefits they creates should be eliminated.

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1 Introduction

This chapter gives the reader an insight on the subject of the current Master Thesis, by presenting a short background of the Thesis, its purpose, how the data collected will be analyzed, and what is not including in the scope of the research.

1.1 Background

There are several methods for maintaining or improving companies' competitiveness (Slack and Lewis, 2010). The ability to continuously improve is of high priority, as it can be a question of the companies' survival (Rose, 2005). If a company does not develop and improve, it will result in a decline of the competitiveness of the company (Hutt and Speh, 2012), as the market of today is dynamic (Lagrosen and Lagrosen, 2006). The dynamic nature of the market of today, result in that things that delighted the customer yesterday will be things that merely satisfy customers of a product of today, and tomorrow the same thing will be required by customers without giving rise to satisfaction (Phillips and Phillips, 2007; Dahlgaard and Dahlgaard 2001), .

In order to stay competitive companies have to focus on retaining a high quality (Smith, 2011). Quality is a key element of customer satisfaction, which in turn is critical for the existence of an organization (Hutton, 2004). This implies that Quality Management (QM) and Continuous Improvement (CI) play a big role in companies that want to be or stay successful in today market (Hutton, 2004). In this thesis quality is defined as having a good understanding of what the customer wants, clearly define what they will get and then stay inside the tolerances of those specifications (Bergman and Klefsjö, 2010).

According to Rose (2005), quality improvements are deliberate processes that are supported by objective measurements and data. One widely used way of improving quality is CIs. Today it exists several methods for working with CI within an organization, some of the most commonly used one's are Kaizen, Elimination of Muda, and Six Sigma. All of these methods have different angles of working with CIs, in order to enhance an organization (Fishman, 2006).

Today, nearly every factory is working on improvements in one way or another (Fishman, 2006). More and more companies are applying the Six Sigma methodology to solve problems (Hoerl 2001). Six Sigma can be seen as a recent evolution of QM, and has been described as a method that represents a new structural approach for improvement to organizations, which includes numerous mechanisms that simultaneously help an organization to handle conflicting demands of exploration and control when improvements are to be made (Schroeder, 2008). In an industry with high competition and shorter times to market, it is important to constantly improve (Howes, 1993). Hence, more effective problem solving with higher quality plays a crucial role in the survival and profitability of the company (Lubit, 2001).

There is much written about how to successfully implement Six Sigma, but not that much written on how to relate it to other improvement work in the organization.

The project for this Thesis has been conducted at Bosch Rexroth Bethlehem, which is a plant with 660 employees located in Pennsylvania, USA. They have used Six Sigma for more than seven years, and feel that it is working fine, but they are also working with other ways for continuous

improvement, and thereby knows that a company has to continuously improve, in order to stay competitive.

One question raised within the company is how they can continuously improve their Six Sigma application. This is basis of this Thesis. To find answers to this question, the current company status will be studied as well as how they work with continuous improvements.

1.2 Purpose

The purpose of this report is to explore how Six Sigma can be related to continuous improvement work at a manufacturing plant, as well as to understand challenges and possibilities in using Six Sigma as a part of a continuous improvement initiative.

1.3 Problem analysis and Research questions

In order to perform a structured study, a pair of research questions has been constructed, that work as a guide for the project, to prevent the project from drifting and to help the researcher to work toward fulfilling the purpose. The following research questions will be addressed:

- In what ways can Six Sigma and continuous improvement initiatives be linked?
- How can Six Sigma be continuously improved?

1.4 Delimitations

This Thesis focuses on studying the Bosch Rexroth Plant in Bethlehem, Pennsylvania USA and its ability to combine Six Sigma methodology and continuous improvements initiatives. Ideas for improvements will be given but the implementation of the ideas is outside the scope of this report.
This thesis is a single case thesis and its findings may not be relevant outside the plant. The thesis purpose is not to explore at the level of individual projects but at the overall Six Sigma initiative. Although the Six Sigma initiative at Bosch Rexroth is heavily influenced from European headquarter, limited time and access do not allow for interviews and other data collection at the European headquarter.

The internship at Bosch Rexroth Corporation was conducted in the QMM (QM and Methods) department. This gave the opportunity to get in touch with several different areas throughout the plant as quality affects everyone.

2 Methodology

This chapter describes how the project was carried out, how participants were selected as well as the results that will be used latter.

2.1 Research Design

This project is based on a combination of research methods, such as interviews, questionnaires and observations. However, the overall approach was Action Research. According to Bryman and Bell (2011, p. 413) Action Research can be defined as "an approach in which the action researcher and the client collaborate in the diagnosis of a problem and in the development of a solution based on the diagnosis."

Traditional scientific research usually gives a generalized solution to problems, and that generalized solution will not always fit the reality of a specific case. That is why Action Research sometimes is preferred. Thus, this method focuses more on specific situations and localized solutions. This makes it suitable when an interest exists of investigating effective solutions to problems that occurs in the everyday work (Stringer, 2007). In business and management, action research is a commonly used method to highlight and overcome gaps between researchers and the managers, which easily can occur (Bryman and Bell, 2011).

The purpose was addressed using action research, in the sense that the author of the report was participating in three different Six Sigma projects at Bosch Rexroth's Bethlehem plant Quality department, in order to get a close insight in how the company works today, during the time period first of February to last of July in the year 2013. In combination with the action research, suitable literature was studied. Dated notes were written continuously during the action research time, in order to collect the researcher's thoughts of the moment as well as what the researcher noted during meetings, and in the daily interaction with people concerning the subject of the Thesis.

The literature study was made continuously, as the research gave hints of what literature needed to be studied in more detail. The purpose of the literature study was to get information of what type of pitfalls that are common in companies that have used the Six Sigma for a period of time as well as to get a deeper understanding of the subject.

One problem that can occur when research only relies on written texts is that those texts may show an ideal world, not reality, and thus have a different agenda, where gaps can occur (Verschoor, 2008). The gaps between documents and reality and the complexity of humans involved in a company are some of the variables that can make it difficult to find solutions for how a plant can improve its Six Sigma use by only search in literature. This is one of the reasons to why Action Research approach was preferable for finding solutions for this Thesis. Another reason was that the Action Research approach gives direct value to the company in form of practical use of the action researcher's outside perspective and knowledge (Bryman and Bell, 2011).

There is no predetermined appearance of how an action research should be performed (Bryman and Bell, 2011), but there are several ways to explain the routines for action research. To give a view of how action research can be done, one way to describe it is as Stringer (2007) does by a Look, Think and Act continuous circle. This enables the initiation of questions in an easy way, so as the

complexity of issues increases, the details also become bigger. In the Look phase, relevant data was collected, this gave the researcher a definition of the case situation. In the Think phase, the researcher analyzed what was happening in the specific situation and theorized on that. Finally, the researcher completed the Act phase, by creating an action plan, implementing the plan, and evaluating the result of the action. However, as Stringer (2007) also mentions, details also got explored during the whole process. This is why some situations had to be looked at several times. There were situations when larger reflection was needed, and some situations where a specific action was thought to be used, the chosen action had to be changed to better fit the situation. The structure for how this research was made can be seen in Figure 2.1.

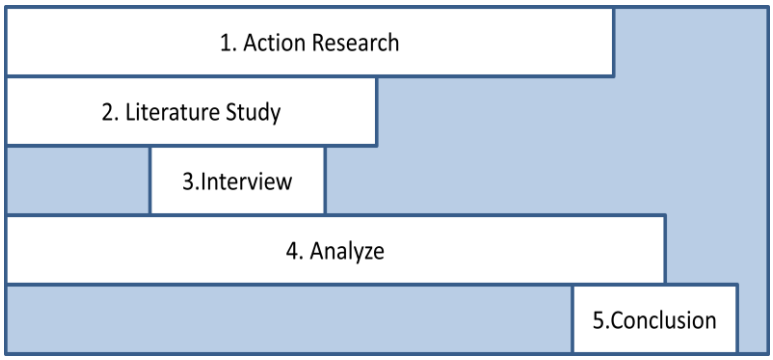


Figure 2.1: Overview of Research Design

2.2 Research Method

The research methods that were used for this thesis were as follows:

- Daily observations during working hours at Bosch Rexroth's Bethlehem plant during February until the end of July.
- Company documents that concerned the subject of this thesis gave an overview of how the company works, as well as giving clues if there were any gaps between the document data, and the observations collected.
- Interviews with employees to cover any gaps between observations and documents.
- Involvement in projects, that contributed to this thesis project in the sense that they gave an action view of how the company works with Six Sigma and continuous improvements in the current state.

The approaches resulted in several sources of data:

- The author's observations during the three Six Sigma projects.
- Other participants' observations during the three Six Sigma projects, as well as the participants earlier experience was collected by interviews and joint reflections.
- Company data that was of relevance to the subject of this thesis and that was approved by the Company for use in this Thesis.
- Literature study materials, such as articles and company documents.

In Table 2.1, the method that has been used for respective research questions and what goals they have the purpose to identify are displayed.

Table 2.1: Research Question Goals and How They Were Reached

Research question	Method	Goal
1. In what ways can Six Sigma and Continuous Improvement initiatives be linked?	Interviews Observation and mind notes	To identify challenges and possibilities of Six Sigma in a Continuous Improvement context
2. How can Six Sigma be continuously improved?	Literature study Interviews Mind notes	To understand practical challenges in using Six Sigma

Overall the action research was completed to create an overview over the current situation in the organization. It was a qualitative case study to help the research to find unspoken processes and behaviors in the organization, as well as to create a continued reflection and opportunity for improvements for the organization as well as for the researcher, during the research process.

2.2.1 Document Study

The literature study was made on articles related to the subject and company documents to create a foundation for the interview questions, and to create an understanding on the subject. The theory created knowledge of best practice and by combining the theory and interviews a view of the gap between best practice and the current state of the company's Six Sigma use could be established.

2.2.2 The Interviews

The interviews were both unstructured, and semi-structured (Bryman and Bell, 2011). Six interviews were conducted. The interviewed people were chosen with thought to capture as large of a view of the subject, from the company's standpoint, as possible, within the timeframe of the thesis. The six people that were interviewed were chosen with help from the company's Six Sigma coordinator, who has the most knowledge of the subject, and knows how different employees' positions are related to Six Sigma. The six positions chosen were:

1. Top Manager (VP), to get a view of how the top of the organization view Six Sigma.
2. Department Manager (DM), to get a view of middle management involved in the Six Sigma resource allocation and project approval.
3. Master Black Belt, Senior Quality engineer (SSC), to get a view of the Six Sigma coordinator.
4. Lean Specialist (BPS), to capture the production system view of Six Sigma.
5. Project Specialist (NFP), to capture the view of someone whose project has been put on hold.
6. Employee Under Greenbelt Education (EUGE), to capture the view of a person new to Six Sigma reflects on how Six Sigma is used and handled.

All of the interviewees have different standpoints, problems, and agendas, and can capture different angles of Six Sigma difficulties and opportunities.

The interviews were conducted without letting the interviewees get the questions in advance, in order to minimize the risk that the interviewees could prepare to give the "right" political answers to the questions. A downside to not giving out the questions in advance is that the interviewees did not have a lot of time during the interview to think through their answers. However, an evaluation of this

downside was made, and the result was that if this downside were larger than the advantage, then the questions would be handed out in advance. At the beginning of the interview, the questions were handed out to make the interviewee feel safer in the situation. Before the interview started, a short explanation was given of the purpose of the interview, and how the data was to be handled. The interview was conducted without voice recorder to create a safe environment for the interview.

The questions were open questions (Bryman and Bell, 2013) to give an opportunity to reflect and develop discussion; notes were taken during the interview to document this. The purpose of the questions was to get an overview over the current situation in the company. Some of the questions were the same for all interviews, while some were unique to an interviewee. The purpose of common questions was to capture the variation in view of the organization and individuals, while the individual questions' purpose was to capture the view of important field specific knowledge in interesting positions for Six Sigma. Time allotment for interviews was limited, and therefore the amount of questions, in order for the interviewees to have time to sufficiently answer all questions. Further open-ended questions tend to take longer time to answer the closed questions. The timeframe for the interviews was between 30 minutes to 1,5 hours.

After all interviews were done, the answers were gathered together under each respective question to enable comparison of answers' similarities, differences, variation, patterns, and gaps.

2.2.3 Observations

The observations were conducted during the six mouths internship that was made at the Bosch Rexroth Bethlehem plant. Mind notes were made during this time as soon as an observation was made. The observations done from the view of a participant and was collected from how people interacted, from group reflections and from specific observed occasions of interest for the research.

2.2.4 Reliability and Validity

In order to ensure as high research quality as possible in this study, the chosen research method is including several methods to collect data, which in researcher terms is called Triangulation (Remenyi et al., 1998). This method corroborates qualitative research with quantitative research and vice versa, which according to Bryman and Bell (2013) results in a greater confidence in the findings, and thereby increases the validity and reliability according to Remenyi et al. (1998).

The risk with observe as participant, is that the researcher is going native, which means that the researcher lose his/ her sense of being a researcher and gets wrapped up in the view of the people he/ she are studying (Bryman and Bell, 2013). But the advantages with the method is that the researcher can come close to the action by building up trust and get a view of the unpolished reality (Bryman and Bell, 2013). Furthermore, the observation by participate made it easier to find company documents of use for the research. The documents gave a view of how the organization standardize processes and work with improvements in a formal way. And the academic documents strengthened the research by giving a view of previous result about the subject and to find gaps between how the ideal way of working and the reality. Moreover, the interviews gave the researcher an opportunity to focus on specific questions that were of interest for the study to that would not be seen in

observations and that gave the researcher an opportunity to get several perspectives that came outside the observed view.

Bosch Rexroth Bethlehem is a plant with multinational employees, with the majority being Americans and Germans; there is a risk that cultural differences affect how the researcher views the situations and responses, as the researcher is from Sweden. Moreover, there is a risk that the results are affected by the fact that the researcher was researching at the company, and did not have any previous knowledge of the organization, as well as the presence of the researcher could affect the behavior or answers of the employees. On the other hand, it created an advantage that the researcher did not have any preconceptions about the people involved, the organization, or their Six Sigma program.

3 Theoretical framework

In this chapter an overview of literature in the areas Quality Management, Continuous Improvement and Six Sigma are described. The review gives the reader a view of the common thoughts about the challenges and opportunities about Six Sigma and Continuous Improvements, as well as to get a deeper understanding of the subject.

3.1 Quality Management

Quality is regarded as one of the main factors that is influencing the competitiveness of companies, as it is a key element for customer satisfaction that in turn contributes to growth (Hutton, 2004). That is why quality also can be counted as one of the main variable that make or break an organization (Hutton, 2004). As if the required quality is not reached in the eyes of the customer, they will soon change supplier of the product or service as well as spread the opinion of the dissatisfaction of the supplier to other customers that probably also will stop buying the product and tell other customers.

In literature on QM quality is seen as the first and most important strategic consideration in order to gain competitive advantages (Crosby, 1979; Deming, 1986). As the market of today is defined as dynamic, which means that what is good quality today does not necessary mean good quality tomorrow, improvements also has to be done continuously (Gremyr, 2010). This is why QM and improvements play a central role in the success of organizations of today (Hutton, 2004; Gupta et al. 2003). In the past, the responsible of quality was dedicated to the quality department, nowadays the understanding is that work on QM has to include the entire organization (Lagrosen and Lagrosen, 2006; Elg et al. 2011).

Sometimes quality is defined as “conformance to requirements” (Rose 2005). The risk with this way of thinking is that a project team that have external contract of explicit specification requirements, think it is enough to reach those requirements and that everything above this goals is waste (Rose 2005). Result will be a satisfied customer, but it will be limited to the current specifications or the customer understands of the technologies and what it is capable of (Rose 2005). This in turn will lead to that the organization want be able to exceed customers’ expectations (Rose 2005). According to Schroeder et al. (2008), organizations need a structure that is both controlling and exploring in order to ensure quality, when they are up against turbulent environment, and this is one things that QM can support organizations with. According to Gupta et al. (2003), QM can be highly effective, but to succeed with it, it is important to first understand the steps in the chosen QM practice (practice such as for example TQM, Six Sigma or Lean) and to understand the nature of practices. Then a creation of an overall tailored management philosophy, which fits the specific organization, has to be made (Gupta et al. 2003).

3.1.1 Quality Management Definitions

There are several different descriptions of QM, see e.g. Andersson et al. (2006) and Rose (2005). As there are many different ways to define QM, due to what angle it is viewed from, it sometimes is hard to fully understand the reasons behind failures of QM in organizations (Singh and Smith, 2006). To better understand the purpose behind QM and to better understand reasons behind failures some definitions of QM will be given.

According to Rose (2005) the purpose with QM is to facilitate for organizations to handle "…all the activities of the performing organization that determine quality policies, objectives, and responsibilities so that the project will satisfy the needs for which it was undertaken" (Rose, 2005).
QM has also been described as a people-focused management system that aims to continual increase customer satisfaction at continually lower real cost (Singh and Smith, 2006). QM is often seen as a system approach (not a separate program or area), and it should be a part of a high-level strategy; it works horizontally across functions and departments, and should involves all employees, from the top to the bottom, as well as include the supply chain and customer chain (Singh and Smith, 2006). One problem that often occur, is that QM is seen as a number of methods, tools, grouping of processes or techniques, when the focus of the whole organization instead should be on customer satisfaction, in order succeed (Lagrosen and Lagrosen, 2006; and Hutton, 2004).

One angle of QM is to see it as being composed of different levels (see Table 3.1). This can be seen as different phases or degree of the implementation (Dale and Lascelles, 1997). Where the first step is a number of practical tools and techniques that can improve certain aspects of how the organization is working to some extent (Lagrosen and Lagrosen, 2006). In the next step there are more comprehensive models and systems, that aims to brings a holistic view to the organization (Lagrosen and Lagrosen, 2006). The last step are principles that should be deep-lying assumptions of the practice in the organization behaviors (Lagrosen and Lagrosen, 2006). The last step is the one that many authors imply to be the most important for the success with QM (Lagrosen and Lagrosen, 2006).

Table 3.1 Levels of Quality Management (Lagrosen and Lagrosen, 2006)

Level	Functions	Supporting the people	Aligning the processes	Understanding the customer
1	Tools/ techniques	Quality circles, team work	Flow-charting, SPC, FMEA, Poka-Yoke, Taguchi methods, The seven quality control tools	QFD
2	Models		The award models, ISO 9000, six sigma	
	Service quality facets	Image	Functional quality	Technical quality
	Behavioural values	Leadership commitment, participation of everybody	Process orientation, Continuous improvements	Customer orientation, management by fact
3	Emotional values	Happiness	Love	Compassion
	Intellectual values	Logic	Discrimination	Expression
	Activity elements	Subject	Process	Object

According to Dean and Bowen (1994) QM can be characterized by tree principles, customer focus, continuous improvements and team work. Were customer focus is the most important one, and has the purpose to satisfy the customers by try to deliver products and services that fulfill the customers' needs, which is the central task of QM (Dean and Bowen, 1994). The second principle, continuous improvement, serves to commit the organizations employees to constant try to find ways to do tasks better (Dean and Bowen, 1994). The idea of this principle is that by improving these processes, organizations can continue to meet their customers' expectations (Dean and Bowen, 1994). The third principle Teamwork, concerns to identifying the needs of all groups and organizations involved in

different types of decision making, in order to find solutions that will be good for everyone involved (Ciampa, 1991). The Teamwork principle implies that there should be collaboration between managers and non-managers, between functions, and between customers and suppliers (Dean and Bowen, 1994). Were the first type of teamwork assumes that non-managerial employees also have the ability to make important contributions to the organizations, if they get the necessary preparation and power to do so (Dean and Bowen, 1994). Teamwork among functions is based on the notion that organizations as systems cannot be effective if subunits just prioritize their own outcomes, instead of sometime prioritize others (Dean and Bowen, 1994). Concerning teamwork between customers and suppliers it is based on the benefits that can be gain of using partnerships as it can contribute with for example synergy, loyalty (Dean and Bowen, 1994). As seen in Table (3.2) the principles are closely related to one another, where CI serves to achieve customer satisfaction by focusing on what the customers need. As the processes targets for CI involves hierarchical, functional, and organizational boundaries, teamwork is essential. Each of the principles is supported by a set of practices which also can be described as activities. The practices are, in turn, supported by a wide range of techniques that have the intention of making the practices effective. In the end, the principles, practice, and tools serve to fulfill the customers' needs.

Table 3.2: Principles, Practices, and Techniques of Total Quality (Dean and Bowen, 1994)

	Customer Focus	Continuous Improvement	Teamwork
Principles	Paramount importance of providing products and services that fulfill customer needs; requires organization wide focus on customers	Consistent customer satisfaction can be attained only through relentless improvement of processes products and services that create	Customer focus and CI are best achieved by collaboration throughout an organization as well as with customers and suppliers
Practices	• Direct customer contact • Collecting information about customer needs • Using information to design and deliver products and services	• Process analysis • Reengineering • Problem solving Plan/do/check/act	• Search for arrangements that benefit all units involved in a process • Formation of various types of teams • Group skills training
Tools and Techniques	• Customer surveys and focus groups • Quality function deployment (translates customer information into product specifications)	• Flowcharts • Pareto analysis • Statistical process control • Fishbone diagrams	• Organizational development methods such as the nominal group technique • Team-building methods (e.g., role clarification and group feedback)

Organizations can compete in several different ways, such as flexibility, delivery, and cost efficiency. Sometimes organizations can chose to compete with more than one of these aspects as described in the Sand Cone Model (Ferdows and De Meyer, 1990) seen in Figure (3.1). This model explains that in order to reach lasting improvements without tradeoffs, efforts should be applied in a particular order, with quality as the foundation, and that the organization’s capabilities should be cumulatively developed.

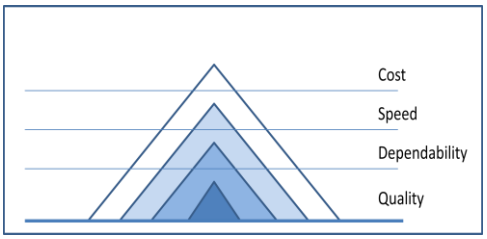


Figure 3.1: The Sand Cone Model

One of the main principles is to structure the organization into work teams (Molina et al. 2006). QM can also be seen as a method for collaboration for the organization with its environment, such as customers and suppliers (Molina et al. 2006). One way of describing QM is through the Cornerstone model (Figure 3.2), that shows that the central part of QM is customer focus, by both overlap, and supports the other parts in the model (Bergman and Klefsjö, 2010).

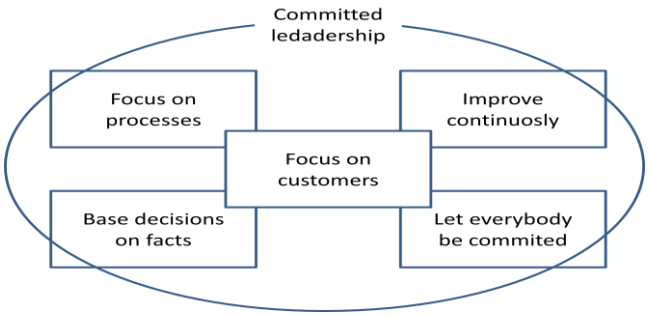


Figure 3.2: Quality Cornerstone Model. A description of QM, by Bergman and Klefsjö (2010)

A closer description of the different parts of the cornerstone model is as followed down below:

1. *Customer focus*
   All efforts should be focused on satisfying the customer (Drummond, 1992). Organizations often gain a lot when defining the customer of any activity.
2. *Leadership commitment*
   Leaders should be committed to quality and also includes top management (Dale, 1999; Deming, 1986, 2000).
3. *Let everybody be committed*
   All employees should participate actively in quality improvements (Juran, 1989).
4. *Continuous improvements*
   Constantly progress, in order to stay competitive in dynamic environments (Lagrosen and Lagrosen, 2006).
5. *Focus on processes*
   In order to avoid that important activities gets neglected due to that the importance of the activities are not understand, an organization should focus on those activities that is contributing to customer value (Sayle, 1994). This is created by finding out what the customers need and want and then consider what activities that are required to satisfy those needs and wants. Further, one should be able to group these activities into processes (Juran, 1988).
6. *Base decisions on facts*
   All decisions made should be based on reliable and documented facts (Juran, 1988), instead of being based on emotion or feelings , but as people are involved, it is easy that emotions take overhand and that decisions would be wanted to be made based on emotion or feelings (Lagrosen and Lagrosen, 2006).

Practices of QM includes product development, statistical control, process management, customer relationships, supplier relationships, the attitude to the work as well as top management commitment (Gupta et al. 2003)and the key concepts of QM include plan, improve and monitoring of quality (Machado et al., 2009) as can be seen in Table (3.3) below. QM has evolved from being mainly a control technique to a system that involves the whole organization (Lagrosen and Lagrosen, 2006). There are studies that indicate that QM includes practices for improvements that affect an organization both internally and externally in technical as well as in social aspects (Molina et al. 2006).

Another way of viewing QM is outlined by Rose (2005), the view includes quality planning, quality assurance, quality control and quality improvement, see Table 3.3. This way of viewing QM is the same as for Machado et al (2009), but is more detailed as it divides Quality inspection into Quality planning and Quality control.

Table 3.3: Quality Management According to Machado et al. (2009)

Quality improvement	Quality inspectrion		Quality assurance
Quality improvement	**Quality planning**	**Quality control**	**Quality assurance**
• Efficiency • SPC • FMEA • etc	• QM-demands/QMS • Quality demands	• Q-control • Q-regulations	• Internal • External

The different methods for QM that exists can be divided into two groups: preventive techniques, and problem-resolving techniques (Machado et al., 2009). The latter can, in turn, be divided into the two other categories: those that help the engineer develop definite aims for tasks in a systematically manner, and those that find causes of existing quality problems in the organization (Machado et al., 2009). According to some of the early proponents of QM (W.E. Diming, J.M. Juran, K. Ishikawa, and P. Crosby), QM is a cultural transformation that includes changes of beliefs, value, and assumptions of how a business should be managed in order to be successful (Gupta et al. 2003).

3.2 Challenges and Advantages with Quality Management

QM is the underlying foundation for current day's CI and operating systems (Hutton, 2004). However, according to Singh and Smith (2006) greater efforts have to be made for customizing QM to continuously fit organizations requirements, as business systems and practices have to be tailored to fit the organizations different needs. It is well documented that several organizations fail when trying to implement a QM programs (Andersson et. al., 2006), the reasons behind the failures are critical to examine.

One of the reasons for failures can be that much of the literature for QM is simplified, e.g. sometimes the magnitude of the required changes that is underestimated (Cieri et al., 1991; Kemeny, 1999). Every organization has different external and internal circumstances, e.g. variations in the history, technology used, markets they are in, products they produce, culture of the employers, environmental conditions and leadership styles (Singh and Smith, 2006). These factors can lead to

initiatives failing, due to e.g. underestimations of time and resources required as well as the magnitude of difficulties that often arise during the process, when the above variations are not taken into consideration (Foley et al., 1997).

One of the advantages of working with QM is that it provides the organization with a common language by creating a systematic way of using the same tools throughout the whole organization (Molina et al. 2006). This is ideal, as a main problem often is that there exists different communication methods within the organization to transferring knowledge, which can lead to confusion. Instead, people will communicate via a system of signs that all are able to understand, (Huber, 1991). Implementation of a common language throughout the organization can also facilitate knowledge transfer between groups in the whole organization (Hoopes and Postrel, 1999).

The effectiveness of QM teams is due to the ability to reach the quality goals that are stated and within the required timeframe, as well as that they have the ability to create strong relations both inside and outside the team (Dean and Evans, 1994). To increase this effectiveness it is proposed that organizations should improve process selection of problems and search of information as well as improving the knowledge transfer (Molina et al. 2006).

3.3 Continuous Improvements

CI is described as "a culture of sustained improvement targeting the elimination of waste in all systems and processes of an organization" (Bhuiyan and Baghel, 2005, p.761). Which according to Fishman (2006) means that everybody in the organization should be self critical on everything and anything on a ongoing daily basis. He continues to describe that the purpose of using CI is to identify, and, to implement ongoing improvements that build upon themselves, which will lead to that the performance level of the organization will continuously be increasing, as this will lead to that the processes continuously is getting better and which leads to that the company gets more competitive, and more profitable (Fishman, 2006). This thought is building upon the perspective that one product or service that a customer thought was delighters yesterday is only a satisfier today and a must be requirement tomorrow (Robinson C., 2009). That is why customer satisfaction only can be sustained over time by continuous improvements of the processes that create products and services, as well as the products and services per se (Dean and Bowen 1994).

3.3.1 History

According to Bhuiyan and Baghel (2005), the modern improvement programs that commonly exist in companies today can be said to be based on developments during the 1800s. By then there were several improvement initiatives done by company managers in the US, encouraging the employees to drive improvements that would bring positive changes to the organization (Bhuiyan and Baghel, (2005); Schroeder and Robinson (1991)).

During the Second World War, the US government set up the "Training Within Industry", with purpose to improve the national industrial output. Latter this program was introduced in Japan; developed to fit to their manufacturing processes. This development gave the improvement term a much broader meaning, by implicating that everyone in the organization should be involved (Bhuiyan and Baghel, 2005; Schroeder and Robinson, 1991).According to Bhuiyan and Baghel (2005) and Owen

J. (2009), as the product development time gets shorter and as the competition gets fiercer in most business areas, the need for organizations to continuously improve increases. This has led to a number of CI methodologies that are based on quality or process improvement concepts; some well known are: Six Sigma, Lean manufacturing, Lean Six Sigma and balance scorecard.

3.3.2 Definition and description

CIs can be done both through evolutionary incremental improvements as well as through radical changes, such as new technologies, although the most common case of improvements are that they develop over time from continuous incremental improvements (Bhuiyan and Baghel, 2005). What is a large change for an individual employee, can be a small change in the perspective of a company owners eyes (Lindberg and Berger 1997). Independent on what scale the improvements are done, it will be supported by techniques and tools that are suitable for finding problem sources, variation, and waste (Bhuiyan and Baghel, 2005).

According to Savolainen (1998) there does not exists any theoretical basis for CIs, rather it should be viewed as a philosophy (Bhuiyan and Baghel, 2005). The term is commonly used as a general term for some quality initiatives that are aiming to improve organizations in different ways (Bhuiyan and Baghel, 2005). CIs is a philosophy that is commonly used in QM, which is a good fit as both seek to achieve excellence through improvement (Bhuiyan and Baghel, 2005). It is a way of thinking that includes every activity in your organization (Corporation for National Service (U.S.), 1994). Deming defined it as a continuous "Improvement initiatives that increase successes and reduce failures" (in Juergensen, 2000). Bessant et al. (1994) defined it as "a company-wide process of focused and continuous incremental innovation". And Bhuiyan and Baghel (2005) defined it as "a culture of sustained improvement targeting the elimination of waste in all systems and processes of an organization. It involves everyone working together to make improvements without necessarily making huge capital investments". Its purpose is to get a better working process that is getting better and better every day, which will lead the organization to higher levels of competitiveness (Fishman, 2006).

3.3.3 Working with Continuous Improvements

CI should be everyone's responsibility in an organization, which means that everybody should strive to have a willingness to learn and share the leanings with others, which is done by using effective communication (Corporation for National Service (U.S.), 1994). CIs has been described to take place at three different levels in an organization, at the management level, group level and at the individual level (Bhuiyan and Baghel, 2005; Webster, 1999). At the management level it is in the form of organization strategy (Bhuiyan and Baghel, 2005; Webster, 1999). At the Group level it is about problem-solving tasks in the broader perspective and at the individual level it is about focusing on improving day-to-day tasks (Bhuiyan and Baghel, 2005). The different focus that different individuals have can be strengthened by a improvement program with a coordinating individual, such as in Six Sigma, as it will help individuals to work toward each other instead of away from each other (Webster, 1999). The mindset should be that, when the organizations not reach its goals, it is an opportunity to improve, and the times when the organization exceeds the goals, it is an opportunity to create new higher goals (Corporation for National Service (U.S.), 1994).

When it comes to CIs, Six Sigma contributes by providing quality measurement' that can be used in the whole (Bhuiyan and Baghel, 2005). Lean manufacturing is a systematic approach to identifying and eliminating waste through Continuous improvements by using three principles, improve material flow and information flow across the organization functions, customer pull and organizational commitment to continuous improvements (Womack et al., 1990; Womack and Jones, 1996). As described in Webster (1999) none of these methodologies can help to solve all aspects when it comes to continuous improvements. That is why different methodologies of continuous improvements can be combined into hybrids, where the methodologies are covering for each other's weaknesses, to create a stronger more comprehensive method, such as Lean Six Sigma that is the most well-known hybrid (Bhuiyan and Baghel, 2005). The method helps organizations to both keep a high production rate and at the same time produce less waste and keep a high quality. Which is something that Six Sigma alone or Lean manufacturing alone could not handle by themselves. As Six Sigma cannot by itself dramatically improve the speed of the process or reduce invested capital, as Lean manufacturing by itself cannot get a process under statistical control (Bhuiyan and Baghel, 2005). Six Sigma focus reduction of variation (Magnusson et al., 2003) and Lean manufacture elimination of waste (Liker, 2004). Lean Six Sigma increase the stakeholders value compare to if the methods are used separately, by increasing the improvement speed in customer satisfaction, quality, cost, process and invested capital (George, 2002). In the way that waste first is removed, this in turn facilitates for variation to be spotted in an easier manner (Bhuiyan and Baghel, 2005). It also takes into account thing that gets overlooked when just Six Sigma or just Lean manufacturing is used, such as what steps in a process that should be tackled first, and in what order they should be applied as well as to what extent and how important improvements should be made due to quality, cost and lead time (Bhuiyan and Baghel, 2005).

The best catalyst for improving an organization, is to create empowered teams, as it has the ability to produce results that exceed those that is done by a less cohesive group or by a individual person (Corporation for National Service (U.S.), 1994).If an organization wants to improve on a regular and ongoing basis they have to have a management systems in place that can guide and sustain these efforts (Snee, 2010). In order to succeed, managers have to decide what the appropriate methods are to be used, to best implement the improvement practices (Bhuiyan and Baghel, 2005). The appropriate methods are created by the managers when they are evaluating process choices, product designs as well as the degree of standardization that should be used in the organization (Bhuiyan and Baghel, 2005). To create a appropriate method the managers also have to create a better understanding of the organization's mission and strategy, and how CIs contributes to fulfill the mission and strategy as well as increase the chances in order to succeed to improve the organization (Jha et al., 1996). However, if the required resources and /or top management support as well as the active involvement of everyone in the organization is missing, organizations are unlikely to succeed with their CI (Bhuiyan and Baghel, 2005).

Both Lean and Six Sigma can be beneficial for a company in several aspects (Assarlind et al., 2013). A reason for implementing both this systems in an organization can be to get the benefits of both CI and breaking through improvements (Assarlind et al., 2013). As they can be described to be complementary to each other more than synergistic in the case of benefits (Assarlind et al., 2013). But, there are also an interaction between the both methods as projects sometimes is passed back and forth between the methods within an organization (Assarlind et al., 2013). One way of using both

methods is to select the parts there Six Sigma and the parts of Lean that fits best to the organization and then adopt those parts to the organization's production system (Assarlind et al., 2013). To support this interaction between the two methods it is suggested by (Assarlind et al., 2013) to improve the specialists' knowledge in both Lean and Six Sigma. According to (Assarlind et al., 2013) both of the approaches can contribute to strengthen each other. More on Assarlind et al. (2013) suggests that organizations have a structure such as improvement hierarchy, as this can help the organization to point out what parts of and whom that should be involved in different projects, which will be depending on the scope and complexity. By using a structure Assarlind et al. (2013) argues that organizations can decrease their barriers such as scopes that are too large, expending or the difficulties of whom that should be involved.

3.3.4 Challenges and Advantages with Continuous Improvements

According to McKee (2009) there are eighth barriers or challenges that have to be taken into consideration when using CI, which are as follows:

- If the objectives of the CI effort are unclear or if there is a lack of strategy of the use of CI or as Process Excellence Network (2013) adds, when there difficult to identify witch improvement effort to prioritize on. This point can sometime be a result of when the organizations Process Management tooling, either is too weak or too complicated.
- If the scope of the CI is larger than the available resources such as availability and skill
- If the stakeholder does not support the CI effort or as Process Excellence Network (2013) adds, if there is exists a collaboration problem between multiple stakeholders.
- If the feedback and participation is poor or as Process Excellence Network (2013) adds, when the engagement from the employees is weak concerning the CI efforts.
- If the industry or organization changes
- If the metrics are ineffective
- If the pragmatic initiatives expands out of control
- If the CI is a attempt to resolve issues that does not exist

Process Excellence Network (2013) also adds on to the list of challenges that can become barriers CI by mentioning that standardization of governing and controlling can be a barrier towards changes, in the sense that it can slow the change towards improvements down or make it impossible to finish off.

The results of CI are often incremental small steps or dramatic big steps forward, independently if it is large or small steps of improvements they provide befits to the organization (Rose 2005), such as:

- Improving the organization's ability to meet the dynamic needs and requirements, as customers' needs always will be changing.
- Help the organization to stay competitive, as the global market is not a static environment, and the competitors will always improve themselves.
- Reduce the costs and increase the profits, which in turn will increase the competiveness.
- Help the organization to develop new processes, technologies and products, as the environment and opportunities are continuously changing.

3.4 Six Sigma

Six Sigma is both a methodology and a philosophy that aims to improve quality by using statistical methods to analyze data, to find the root cause of quality problems as well as to implement the solution and control that the solution is maintained and works as desired (Markarian 2004). It was first introduced in the mid-1980s by the Motorola Corporation, as a result of the company's strategy to focus on reducing product defects (Carter P., 2010) and as a way of measuring process quality using statistical process control (Bhuiyan and Baghel, 2005), which would lead to improvement of quality (Linderman et al. 2002). The term Six Sigma can be described as "3.4 bad customer experiences for every million customer opportunities" (Eckes, 2003, p. 13).

3.4.1 Purpose and Practices

Six Sigma is sometimes described as the latest banner of QM (McManus, 1999). Top management leadership is an essential part of both QM and Six Sigma (Harry and Schroeder, 2000; Kaynak, 2003). However, Six Sigma contributes with a well-defined structure that demands more involvement of leaders in improvement projects, compared to earlier QM (Schroeder et al., 2008). The tools and techniques in Six Sigma are similar to prior QM approaches, but as it provides an organizational structure, it helps organizations to better control process improvement activities, and creates a common language that enables problem exchange between organizational members with different backgrounds (Schroeder et al., 2008).

The tools that are used in Six Sigma are not unique for this Six Sigma, however ***the structure*** of how they get used is unique (Hoerl, 2001; Schroeder et al., 2008), as well as the ***focus on financial*** metrics that Six Sigma uses in order to find the benefits that is expected from the efforts (Bhuiyan and Baghel, 2005; Schroeder et al., 2008). One example of that is that Black Belts and Champions are expected to contribute with between $100,000 and $250,000 of profit every year (George, 2002).This financial focus on project level in Six Sigma can be compares to for example TQM were it is on the organizational level (Schroeder et al., 2008). A third differences that Six Sigma have compared to other management tools, such as TQM, is that Six Sigma have ***different type of training for quality*** specialists at different levels (Schroeder et al., 2008).

The process of Six Sigma can be done in two ways, DMAIC and DMADV (also more known as DFSS, which stands for Design for Six Sigma). The first stands for Define, Measure, Analyze, Improve and Control (Eckes G., 2003). This first method is suitable for already existing processes and focuses on minimizing the variation (Gremyr,2011), and is what this project focus on. The method is based on defining problems, measuring impact of the defined problems, determine what the root causes for the problems are, and than creating and testing hypotheses for the problems (Eckes, 2003). The project model in Six Sigma helps the project teams to connects specific tools with specific steps in the process in order to create a work structure that facilitates problem solving of complex tasks (Schroeder et al., 2008). DMAIC serves to improve effectivity and efficiency on the chosen improvement projects (Eckes, 2003). The process has its similarities to the PDCA cycle (Shewhart, 1931, 1939), but it integrate the specific tools into the steps in a higher degree (Schroeder et al., 2008). Moreover it involves different people in different steps (Schroeder et al., 2008), as further is described under the subtitle responsibilities later in this chapter.

According to Schroeder et. al. (2008) there is a need for more scientific research in the field of Six Sigma. In addition, Parast (2010) points out the organizational and contextual variables that either hinder or simplifies the Six Sigma implementation in organizations is an area that is in need of research. Even if there is an agreement among several researchers that Six Sigma has the ability to improve processes, there are not many studies done on the effect of Six Sigma on organizations over time (Foster, 2007).

3.4.2 Definitions

As mentioned in earlier chapter Six Sigma has been defined in literature in a variety of ways. Below are some of the different definitions.

Table 3.4: Different definitions' of Six Sigma

Author	Definition of Six Sigma
Schroeder et al., 2008 , p. 540	"Six Sigma is an organized, parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives"
Linderman et al., 2003, p. 195	"Six Sigma is an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in the customer defined defect rates"
Blakeslee, 1999, p. 78	"a high-performance, data-driven approach to analyzing the root causes of business problems and solving them"
Hahn et al. 2000, p. 317	"Six Sigma is a disciplined and highly quantitative approach to improving product or process quality"
Harry and Schroeder, 2000, p. 7	"business process that allows companies to drastically improve their bottom line by designing and monitoring everyday business activities in ways that minimize waste and resources while increasing customer satisfaction"

As can be seen above in Table (3.4), there is a diversity between different definitions of Six Sigma and Hahn et al. (1999) argues that Six Sigma has not been carefully defined anywhere in academic literature. However, each of these definitions shows different angles of Six Sigma, and it can be good to be aware that these differences also exists within the same organization (Schroeder et al., 2008). Although there are large differences between the definitions Schroeder et al. (2008) argues that the definitions emphasizes the idea of getting to the root cause of problems, to improve a process. According to Schroeder et al. (2008) this is an important fact to bear in mind since many teams tend to jump to the conclusions and attack the symptoms instead of finding the underlying problems in the organization.

3.4.3 Responsibilities and Roles

When it comes to Six Sigma and responsibilities, there is a high focus on management commitment, but there is less writhen about what it actually means (Eckes, 2003; Kwak and Anbari, 2006; Sharma, Chetiya, 2012). The core of Six Sigma is to be a management philosophy for organizations and that require that management is actively involved, and not only support it (Eckes, 2003). It is the executive management's responsibility to create the strategy, which ensures that Six Sigma not only will be a set of tools and techniques in the organization (Eckes, 2003; Kwak and Anbari, 2006).

The organizations managers or process owners, which also is denoted the Champion, are the ones that are responsibility for identifying the key processes, measure the effectiveness and efficiency as well as identifying the worst performing process of the organization (Eckes, 2003; Magnusson et al.,

2003). This is done in order to create a good foundation for the Six Sigma projects to be able to create results of improvements in the organization (Eckes, 2003). The first step that management has responsibility for doing when it concern Six Sigma is to create the business process management system (Eckes, 2003). The responsibilities in the Six Sigma preparations are as following in Figure (3.3).

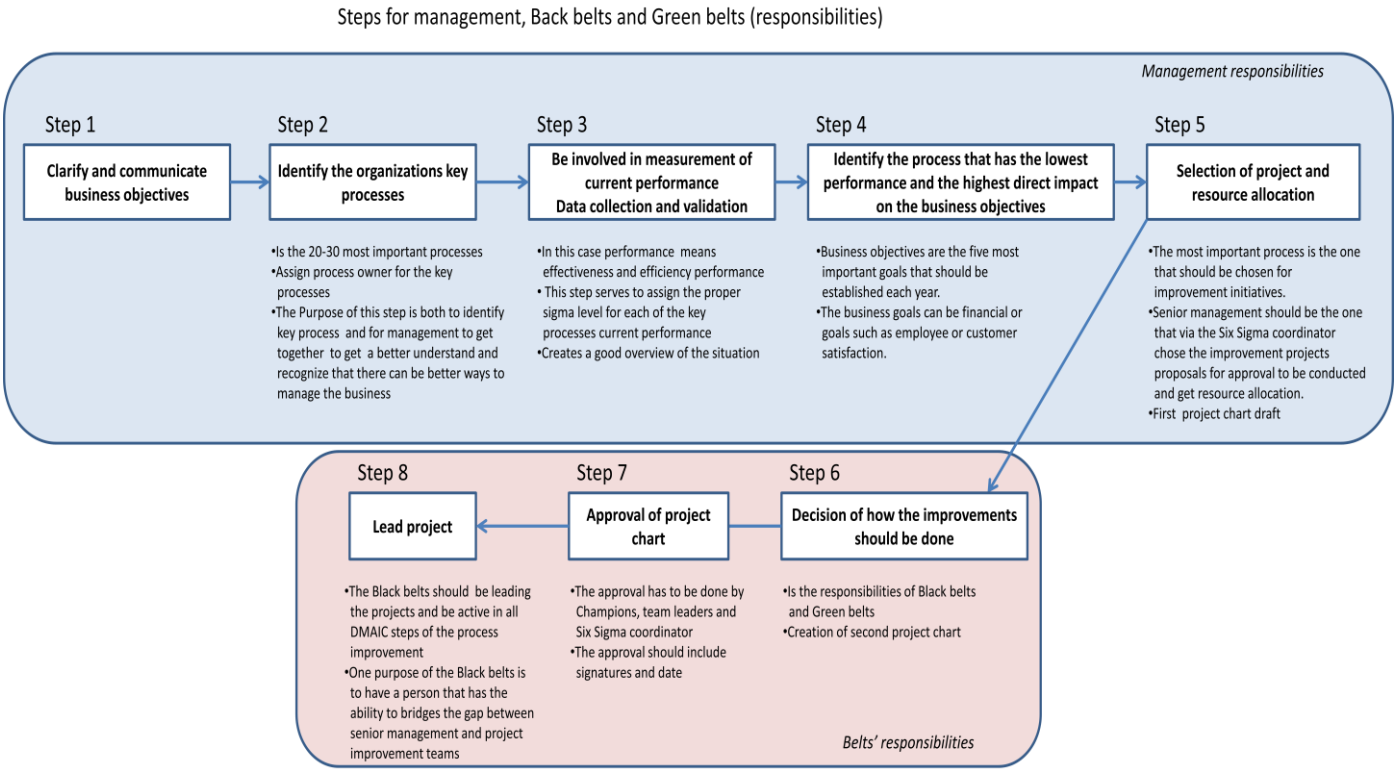


Figure 3.3: Steps for responsibilities in Six Sigma project preparations (Eckes G., 2003; Schroeder et al. 2008)

The main task of the Champion is to guide the project team but he/she is usually not a full-time member of the team (Eckes, 2003). They chose the team, provide the resources needed and remove team's roadblocks (Eckes, 2003; Magnusson et al., 2003). The task of the Black belt is to be a team leader and is responsible for the day- to-day work that is associated to the team (Eckes, 2003; Magnusson et al., 2003; Snee and Hoerl, 2003). This can be thing such as keeping the team on track by see so that it meets the DMAIC specific duties (Eckes, 2003). The team leader can also be a Green belt which has responsibilities such as organizing on the side of being the team leader (Eckes, 2003). The Master black belt is a non-full time team member that can be seen as a internal consultant, whose responsibility is to provide the team with the more technical aspects of the work (Eckes, 2003; Magnusson et al., 2003). Finally there are the rest of the members involved which should be the subject experts which will conduct the actual work of the project (Eckes, 2003).

Champions are actively contributing in the define phase and has more of an supporting role in the rest of the steps, Process owner should have a active part in the control phase and more of a supporting role in the other phases, and the Green belts are most active in the measure, analyze and improve phases (Schroeder et al., 2008)

According to Linderman et al. (2003) the purpose of the Champions is to identify strategically important projects for the improvement teams as well as provide the team with recourses needed. The Black Belts are supposed to lead the improvement project, and the Master Black Belts (MBB) are to work as specialists and can be viewed as internal consultants (Linderman et al. 2003). In terms of the Green Belts the purpose are to work as part time improvement specialists supporting the improvement projects (Linderman et al. 2003).

3.4.4 Why and When to Use Six Sigma

According to Schroeder et al. (2008), the reason for that Six Sigma is being used among organizations instead of other QM approaches is not due to its philosophy or quality tools and technique, as they already exists in other QM approaches. The reason that they chose to us it is due to that it is a good way for the organization to organize and structure complex tasks (Schroeder et al., 2008), and a way of further enhance business performance (Hahn et al., 2000). Some organizations feel that Six Sigma fit their organization in a better way than other QM methods do, such as TQM or QFD (Schroeder et al., 2008). Many CEOs thinks that it is a attractive method due to the disciplined approach with a parallel middle level organization structure that provide the organization with financial return (Slater, 1999).

It is important to know when Six Sigma is suited to use or when it is not suited to use, as this will limit the number of unsuccessful projects (Goh, 2002; Tatham and Mackertich, 2003). It is important to bear in mind that Six Sigma is not a universal method that fit in all occasions in an organization, and it does not fit in all organizations (Goh, 2002). It is best suited for repetitive operations, when there is an improvement need (Goh, 2002). Six Sigma is a suitable method when there is a need for finding root causes to why something have gone wrong, but it is not a method for developing a understanding of what is beneath the CTQ, that should be handled by other methods, as well as when there is a wish for evaluating how much knowledge, passion, commitment, innovation or imagination a task is worth (Goh, 2002).

3.4.5 Potential Improvement Areas for Six Sigma

According to Schroeder et al. (2008), Six Sigma should be viewed as a change process for organizations. Which could improve the implementation of the Six Sigma process and what it is that actually has to be changed, as well as it could lead to an improved way of managing the change process (Schroeder et al., 2008). More on to improve Six Sigma use, it is advised that managers should have the right to initiate projects, as it will help the organization to base the project selections on strategic importance instead of convenience (Schroeder et al., 2008). For an organization to be successful in the use of Six Sigma (Gitlow and Levine, 2005; Snee and Hoerl, 2003) leaders has to be involved in the ongoing execution of the projects. Further, senior Champions (often VP) should perform tasks such as facilitating project selection, defining project charters, selecting Black belts and resources, removing roadblocks for project teams, and conducting review over the progresses in examples Tollgates. The good thing with Tollgate reviews is that it forces people to look at how they work and limite the freewheeling that are common when it come to work with problem solving (Bastien and Hostager, 1988; Weick, 1993). It is important that the DMAIC method is followed and that there is now solution offered until the problem is clearly defined (Linderman et. al. 2003).

To make it possible to create the common language that Six Sigma can contribute with, it requires that the metaroutines gets institutionalized in the whole organization (Scott, 2001). This is why it is important for top management to be aware of how they want Six Sigma to be communicated through the organization. It is also important for the success of Six Sigma that organizations understands the customers present and future needs, as the true customer need is the root of Six Sigma (Deming, 1986; Deming, 1994). The customer requirements help the organization to establish their project improvement goals and pinpoint where to put the efforts (Linderman et al., 2003). According to Schroeder et al. (2008) the customer requirements is something that that has to be a part of the Six Sigma process. The importance of customer focus is not anything that is unique for Six Sigma, it is always part of any QM initiatives (Schroeder et al., 2008). Other topics that this methods care as important for success are the importance of cross-functional teams, design for manufacturability, robust design and QFD (Schroeder et al., 2008). Continuing on customer focus, it is important at two levels organizational and project level (Schroeder et al., 2008). In the first of the two levels it is important to use customer input for establishing with processes and products that are in need for improvements (Schroeder et al., 2008). At the second level it is important to use the input for defining what attributes that are critical to quality (Schroeder et al., 2008). Moreover, as data and measurement objectivity are important factors for success when using Six Sigma, the standard statistical quality tools has to be used when they are needed (Linderman et. al. 2002).

It is important for the success of Six Sigma project that there exists real examples, as they will lead to increase motivation and learning (Hoerl, 2001). The examples should show beginning to end processes that illustrates the overall flow of the DMAIC process as well as how the individual tools can be integrated in the improvement process (Hoerl, 2001). There is also important for the success, that the case examples are as close to the projects as possible, as one of the hard things when a team is new to a method, is to fine the proper flow from phase to phase (Hoerl, 2001). However, it is also recommended to motivate each tool used with an example of how it has been used in similar areas (Hoerl, 2001).

According to Goldstein (2001) there are 13 factors that contributes towards success of Six Sigma, which are; Deployment Plan, Active participation from the senior executives, Project review, Technical support, Full-time vs. Part-time resources, Training, Communication, Project selection, Project tracking, Incentive program, Safe environment and Supplier plan and Customer “WOW“. For an elaborate description of each factor see Appendix B. More on, Goh (2002) describes twelve additional attributes that can be seen as the way of best practice for using Six Sigma, only rely on measurable items and focus on organizational learning (for a full account see Appendix C).

3.4.6 Challenges and Advantages with Six Sigma

According to Schroeder et al. (2008), there is a need for academics to better understand Six Sigma, in order to prevent overhyping as to prevent organizations from quickly dismissing it as something that is not new. Organizations has to get a deeper understanding of Six Sigma to understand when it is a appropriate method to use and whom it is suited for, to increase the likeliness of success (Schroeder et al., 2008).

One challenge that organizations that start using Six Sigma have to take into account is the criticality of the first projects (Eckes, 2003). It is important that that the first projects end up successful, as this will be working as a good example in their organization, as well as that they will serve as guiding examples for following projects, that can use their lessons learned to improve the implementation of the method (Eckes, 2003).

A pitfall that some organizations makes that are new in the field of Six Sigma is that they do not want to invest a significant number of full-time improvement specialists, instead they assign the improvement tasks to already overloaded employees to deal with as part time tasks (Schroeder et al., 2008). The risk is as Six Sigma use challenging goal setting, that it gets too difficult and the performance will decline (Erez and Zidon, 1984). When individuals view goals as impossible to reach, they will not work that hard to try to reach them. One way of preventing challenging goals from appearing impossible is to have training in process improvements tools and methods mitigating the difficulties (Linderman et al. 2003). Another challenge is to prevent team members from immediately jumping to conclusions, which is a common pitfall (Linderman et al. 2003). To limit the risk that the team is not properly following the DMIAC steps, Linderman et al. (2003) suggests that the leaders should identify the mechanisms that promote the right tools and methods to use, and then use this as incentives for the team to use them.

Although Six Sigma is based on established methods (Schroeder et al., 2008), there are several advantages that organizations can gain from using Six Sigma, such as giving the organizations a structured way to deal with improvement work (Schroeder et al., 2008). It helps organizations to be more ambidextrous (Daft, 2001) which means that it give the organization the ability to be more organic when it is needed, such as when generating new ideas, and more mechanistic when the ideas will be implemented (Schroeder et al., 2008). This helps organizations to handle the conflicting demands of exploring and controlling when improving processes and products (Schroeder et al., 2008).

Another advantage with Six Sigma when institutionalized, is that it creates a common language and problem solving method, which help the organization to overcome barriers that can occur when individuals or departments interpreted subjects from different angles or perspectives (Schroeder et al., 2008). Six Sigma helps organizations, by using a structure approach to become learning organizations, which can lead to insights about how to create, retain and spread knowledge (Choo et al., 2007; Lapré et al., 2000). The structure way that Six Sigma contributes with also help teams to investigate alternative solutions to the problem and avoid jumping directly to the conclusions (Schroeder et al., 2008). It also can help the organizational leaders (champions) to monitor the data measuring routines by the use of tollgates reviews in all steps of the DMAIC phases (Schroeder et al., 2008).

When an organization base their goals on the metrics that is developed from Six Sigma, they have the opportunity to set up challenging and specific goals which is proven to give better results than vague non-quantitative goals (Locke and Latham, 1990). This can create team alignment, provide a base for feedback and help the organization to measure their improvements (Ivancevich and McMahon, 1982). The metrics also ensure that the organization focus on the customer throughout the improvement process, as it is acquired to be able to calculating the sigma value of the process (Schroeder et al., 2008).

The mechanisms of Six Sigma that deals with leadership engagement and strategic project selection contributes to the organization in the way that it help the organization to achieve integration in multiple levels (Schroeder et al., 2008). The strategic project selection helps the organization to prioritize with projects that should have the highest priority with dos not exist in other QM methods such as TQM (Bhuiyan and Baghel, 2005). Six Sigma also shows organizations that not all projects has short term financial returns and that also the pure strategical values has to be considered (Pande et al., 2000), and that projects can be needed to be done irrespective of organizational cost (Bhuiyan and Baghel, 2005).

3.5 Common pitfalls for improvement initiatives

According to Snee, (2010), there exist common mistakes or pitfalls that are made by organizations working with improvement initiatives, such as for example Lean Six Sigma. They are primarily found in two different areas Snee, (2010): leadership and goals.

1. *Low level of leadership from top management,*

There are too low degree of leadership from top management, which means too low level of top management involvements in deployment plans, strategy, goals, etc. This includes poor or infrequent management reviews, poor support from the finance department Human resource department IT department maintenance department Quality Control Lab as well as that the top talents in the organization are not fully used. Communication of initiative and progress is poor, and there are a lack of appropriate types of appreciations. (Snee, 2010)

This pitfall is being avoid by having involvement form Top management , which means to create a real feeling of that it is of high priorization that the improvements has to be done and that that it is a important step towards success. The top managers have to have be able to remove obstacles, allocating resources to the tasks. They have to, on regularly basis review its progress, and ensuring that appreciation by using right type of incentives are reached by participants. (Snee, 2010)

2. *The projects are not tied to organizational goals and financial results,*

This occur when management of the selection of improvement projects are too low or wrong. It gets hard to defined project scope, metrics, and goals and it can lead to that wrong people gets assigned to projects. Sometime project leaders and teams will not have sufficient time to work on projects, which results in that projects will last more than six months. Also a low level of technical support from improvement MBB can result in long project time as well as when project teams are to big (which is more than four to six persons). (Snee, 2010)

This pitfall is being avoid by focusing on improvement and not on training, as training is not a goal in itself. When combining the training with real project improvements, it will increase the learning as well as contribute to creating employees that are more committed. When a project will take longer time then eight-moths, it is of suggestion that the project should be divided into smaller sub-projects that can be run in sequence or parallel. (Snee, 2010)

It is of high important that important improvement projects are assigned to the most talented people in the organization (Snee, 2010). As the surrounding people know how is talented and not, they will most often prioritize the projects were they know the most talented people are (Snee, 2010).

3.6 Synthesis of theoretical framework

Figure 3.4 summarizes the theoretical conclusion of the benefits and challenges that are find in academic literature of Six Sigma respectively CI. In the Figure 3.4 the findings has been clustered together in groups that describes the main topics of respectively benefits and challenges for the Six Sigma and respectively benefits and challenges for CI, in order to make it easier to see connections and contradictions. Moreover, as can be seen, resource allocation is something that is a challenge for both Six Sigma and CI and thereby risks to effect both Six Sigma and CI in a negative manner.

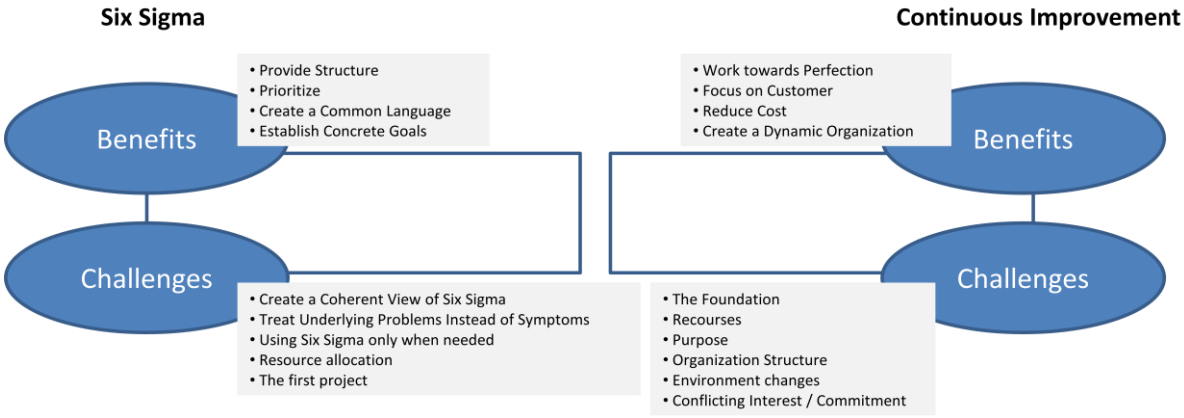


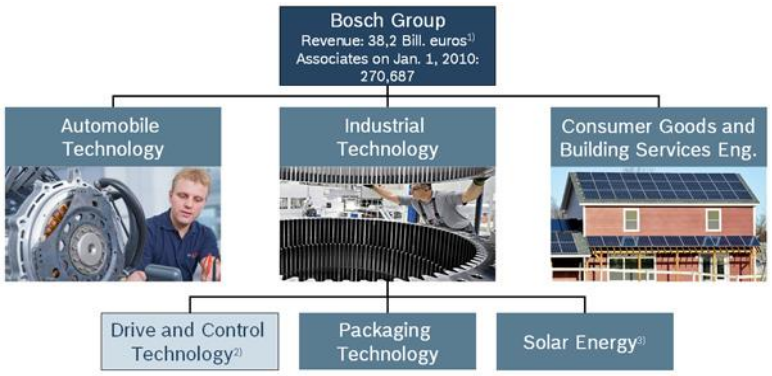
Figure 3.1: Framework of theoretical synthesis

4 Case company background

In the following the case company is described based on company material.

Bosch Rexroth is one of the leading specialists of drive and control technologies in the world. Rexroth is also market leading in industrial hydraulics over the world, and have a broad range of hydraulic and electronic components and an internationally unparalleled systems competence geared to specific industries. The brand Rexroth offers solutions for industrial automation, mobile applications and commercial vehicles as well as for renewable energies to drive, operate and move. The company has more than 500.000 customers in the field of premium electric, hydraulic, mechatronic and pneumatic components and systems. Bosch Rexroth was formed in 2001 when the automation technology business unit of Robert Bosch GmbH merged with Mannesmann Rexroth AG. This branch of the BOSCH Group gained with nearly 35.000 associates a total sale of about 5.1 billion Euros in 2010.

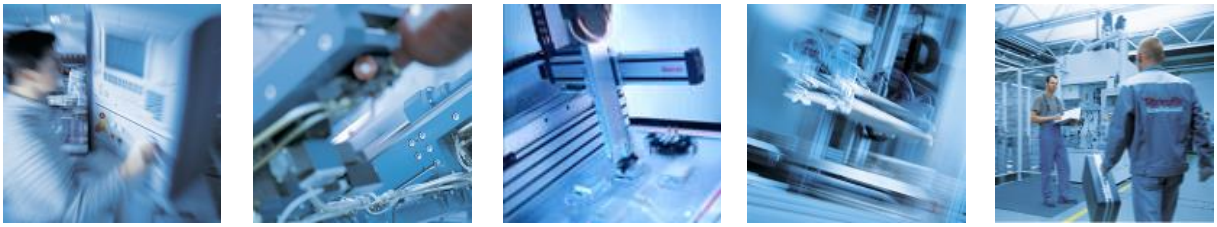
The Rexroth Plant in Bethlehem is the Northeast Regional Center for Rexroth Industrial Hydraulics. It was founded in 1974 because of outgrowing offices in Easton, PA. In 1975 the production of directional, pressure and flow control valves started in Bethlehem. With about 575 employees Rexroth Bethlehem had a volume of sales of $ 138 Mio. in 2010. Nowadays Rexroth Bethlehem produces power units, cylinders, manifolds, valves and appropriate electronic devices. The Figure 4.1 gives an overview of how the Bosch Rexroth Bethlehem Plant is located within the Bosch group.



[1] including other, [2] Bosch Rexroth AG (100% Bosch), [3] Bosch Solar Energy AG

Figure 4.1: Rexroth within the BOSCH Group

Rexroth "Drive and Control Technology" belongs to the "Industrial Technology" branch of Bosch, next to packaging technology and solar energy (see Figure 4.1). Bosch-Rexroth consists of five different business units. Each unit is responsible for a specific product group. The different Rexroth business units are showed in Figure 4.2:



Electric Drives and Controls	Hydraulics	Linear Motion and Assembly Technologies	Pneumatics	Service

Figure 4.2: Rexroth Business Units

The Strategy for the Bosch Rexroth plant is the same as for all Bosch companies. It is built on the house of orientation (Figure 4.3). Which shows that the organization should build its foundation on core competencies, Bosch Business System and values. From this foundation the Mission can be made that will lead to create the Vision of the organization.

Figure 4.3: Bosch House of Orientation

The Values act as a compass in times of change, and point out the direction which cultural change within the company is meant to take. The values are designed as a part of the company's foundation for the necessary strong economic development as well as to shape the cooperation among associates and to. The values are as follows:

- Focus on Future and Result
- Responsibility
- Initiative and Determination
- Openness and Trust
- Fairness
- Reliability, Credibility, and Legality
- Cultural Diversity

The Bosch Business System (BBS) is the way the organization is learning, which in turn helps the organization to stay in the competing front. BBS helps the organization to implement its Vision, since they need to continuously develop and manage change. The BBS contributes with a systematic methodology that show the organization a concrete way on where they need to re-invent themselves, and how well they are mastering these shifts and structural changes in practice.

The core competencies is an interrelated mix from which the organization derive their competitive advantage, and as well as forms the basis for the future development of the company. They are as follows:

- Strategic far-sightedness
- Innovative strength
- Efficient processes
- Quality and reliability
- Global presence
- Human resources development

The mission reveals the focal points of the organizations actions. The company's objective is to continuously improve its internal processes. The organization mission is called BeQIK (see Figure 4.4) and it stands for greater speed in everything that they do. The (Q) stands for Quality, (I) stands for Innovation and (K) stands for Customer Orientation. This purpose serves to ensure the ability to generate the profits needed to secure the organizations growth and economic success, which will guarantee the long-term survival of the company.

Figure 4.4: Mission

The company vision is to "take advantage of their global opportunities for a strong and meaningful development". Their "ambition is to enhance the quality of life with solutions that are both innovative and beneficial". They strive to focus on their "core competencies in automotive and industrial technologies as well as in products and services for professional and private use". They strive for sustained economic success and a leading market position in everything that they do. By using entrepreneurial freedom and financial independence they can be guided by their actions towards a long-term perspective.

They want that their customers will choose them due to the organizations innovative strength and efficiency, and for their reliability and quality of work. They strive for that there organizational structures, processes, and leadership tools are clear and effective, and support the requirements of their various businesses. The diversity of their cultures should be a source of additional strength, and the employees should be able to feel proud over being a part of Bosch.

The official vision of Bosch Rexroth is: *"We from Bosch Rexroth are driven by the enthusiasm to use our outstanding application, development and production know-how to make innovative products with additional benefits for our customers in the investment goods industry at competitive prices.*

Thanks to our customer-orientation at all levels, we are constantly growing as a company and experiencing sustainable profits.

We are proud together by our appreciation of all that is new and innovative and our commitment to achievement, fairness and cultural diversity. "

5 Empirical Data

This chapter focuses on the empirical findings. The findings are based on observations, interviews and company documents. When this study was conducted the company's Quality department was the owner of the organizations Six Sigma program and the BPS department was responsible for the organizations Lean production system and thereby also the organizations CI initiatives.

5.1 Quality Management

The main implication that the interviewees had about QM was as a systematic way to create structure to an organization in order to ensure quality, were quality was defined as in Table 5.1. One interviewee saw QM as a way of creating structure and assist him to be aware of tools at his disposal. Another interviewee described QM as way of supporting the organization, in the sense that it helps organizations to reach good quality, and to implement structure to the management system and methods. It can also be seen as a way of thinking. The first thing that came to one interviewee's mind when he was to describe QM was the Quality department and a systematic way of planning and assure that quality is reached. Another interviewee saw it as a way to increasing throw output time (i.e. shorten the process time so that more things can be made and delivered within a certain timeframe. He also saw it as a way to create structure and procedures, satisfy customers, and help the daily operation to provide a result that give employees less stress to manage. One interviewee described it as a way to balance cost versus delivery. QM was finally described as a way to manage the organization system, and that the challenge is to train employee to be more autonomous.

Quality can be defined in several ways. As was described during an introduction seminar at the company, quality depends on were in the company you are working. If a person is working at the service department he/ she will have one definition and if a person is working as a designer or at the logistic department he/ she will have other definitions of quality. In Table 5.1 below the definitions of quality given by interviewees are contrasted to the company's definition.

Table 5.1: Definition of Quality

Interviewee Definition of Quality	Company Definition of Quality
● Matching performance to requirements. ● Being able to provide a product to given parameters. ● Doing the job correctly ● Meeting the customers' demands and Kano model upper third[1]. And doing it right the first time. ● Getting the customer parts specified consistently within a controlled process ● See it as a system, and it is important to know the process. The quality system goal is to continuously improve processes, create long term balanced goals for customers, employees and results. The possibility to take care of everything that occurs fast and take care of it fast. Have goals for everything as well as understand and improve processes.	1. Our goal is to fully satisfy our customer's expectations through the quality of our products and services. 2. Quality and quality improvement is every associates' responsibility and ultimate goal - from the board of directors to apprentices. 3. Our directives, processes, systems and goals are based on requirements from international standards, customer expectations, our knowledge and experience. Knowledge of and compliance with these directives and processes is the foundation of our quality. 4. Quality means doing things right in the beginning, thus preventing failures in the end. CI of the quality of processes lowers costs and increases productivity. 5. Avoiding failures is more important than eliminating defects. We systematically apply methods and tools for preventive quality assurance systematically, learn from mistakes and eliminate their root causes without delay. 6. Our suppliers contribute substantially to the quality of our products and services. Therefore our suppliers must live up to the same high quality standards we have adopted.

As can be seen in Table 5.1, there were several ways of defining quality. The different views of the quality definitions were closely related to where in the organization the interviewees were working, which makes it a good idea for the organization to have several proposals for employees to create the idea that fits best to the department that they are working in.

5.2 Continuous Improvement

As was observed the company use several different improvement methods, which are suited for different type of improvements, some of the methods that were mentioned were the Bright Ideas program, Suggestion cards Program, Six Sigma Program, CIP (Continuous Improvement Processes), PDCA, Training, Effective meeting training, Workshop in improvements, and 8D.

According to the interviewed the company works with improvements at different levels. There are improvement projects that are coming from top management, and there are those that are initiated from below. As observed, they have several ways of collecting ideas of different kind of improvements. According to top management the company has rewards for continuous improvement processes. He also explained that the company sets up goals for the organization's improvement system that inspire improvement work and encourage root cause analysis, and to avoid resolving symptom until the root cause is found, in order to improve the company in the long term. He continued to explain that they do not want to improve just for the moment, and that it is important to control the improvements so it gets stable and does not go back to the previous state. One way that the company is handling the control of improvements is by creating company standards.

[1] Kano model upper third, by that he meant the Attractive value elements or "delighters" that according to Zokaei and Hines (2007, p.238) "are neither explicitly demanded nor expected by the customer but are latent. Their absence does not cause dissatisfaction since the consumers are not aware of them; however, strong fulfillment in this dimension delights the consumers resulting in more than proportional satisfaction"

5.2.1 Lessons Learned

One observation that was made in the organization was that an idea does not have to travel far before a decision is made. One senior engineer said that if there is no clear rule, a person has to decide his or her own rules, and if someone protests, it is not worse than that. One negative thing with this is that it can lead to activities running out of steam when people feel that a task is no longer on his or her plate. Also, the plant is a part of a large corporation, and there are many decisions that are made centrally and cause the organization to be inflexible. More on, it was observed that depending on an individual's position, and or in combination with his or her personality, it can vary how hard or easy that individual will have to get other people to do things that he/ she request the other person to do. One perspective that a senior engineer saw as a challenge for improvements and lessons learned was that "It is hard to work with improvements when a process continuously is changing". As was observed, challenges also occur when there is a high staff turnover rate, as it leads to that "thing that was obvious yesterday is not obvious today"; as people who was the owner of the knowledge are gone, and did not transfer that knowledge. It is important to figure out how to make an individual's knowledge the organization's knowledge, and how to develop the organization's learning, because it helps the organization to use their time more effectively. This minimizes the need for "inventing the same wheel over and over again".

All interviewees that were asked how the company handled "lessons learned" agreed that this was an area for improvements. One interviewee stated, "I don't know how the company handle lessons learned, and that is frustrating to me". Another answer was "not well, it works like a pendulum and it is hard to not let the issues fall back into the background". One interviewee that did not feel like the company handled lesson learned very well, described that in ten years he had only gotten one email with a suggestion of something that he could considered for his department from another department that had a similar task that they had a good solution for. Otherwise a lot of knowledge is not shared to the organization so he several times he has been repeating the same thing over and over again. He added that he thought that lots of things could be standardized that are not standardized today, to save time and effort in the daily work. According to one manager that thought the subject were possible to improve, explained that today they use tools such as 8D, FMEA and more. He also used a network room were his contact network can upload thing that they think is good or ask questions. A senior engineer explained that a high staff turnover rate and the fact that people are moved around a lot, makes it difficult to learn from experience.

According to one interviewee the way the company is standardizing Six Sigma is by creating project charts and Power Points slides to summarize fields of interest. Another interviewee explained that they have one budget meeting per year for the projects. And that they use the way of working in the project as they have been taught at the Six Sigma course, with DMAIC. He also stated that it is the project that the manager is putting the most pressure on that is the one that is moving forward.
Concerning lessons learned for Six Sigma, one interviewee stated that there does not exists that mush data of unfinished projects. And as was observed, it was really hard to get any information of previous Six Sigma projects. Which also was shown during the observation, it indicates that it is hard to learn from the previous Six Sigma projects in the organization and that the Six Sigma history in the plant gets lost within a short time.

One of the tools used within CI at the Bosch Rexroth Bethlehem plant is 8D. This was explained by one manager by an example of a fire and how to handle that:
1 Were are my team (e.g. family)
2 What is it that happens (it is burning)
3 What should I do (take me out of the house).
4 Then you can think of root causes

8D has predefined phases: D1.Establishing Problem Solving Team, D2.Problem Description, D3.Containment Actions, D4.Cause and Effects Analysis (Use of Ishikawa diagram and 5xWhy technique or comparable analysis), D5.Defining Corrective Actions and Proving Effectiveness, D6.Implementing Corrective Actions and Tracking Effectiveness, D7.Establishing Preventive Actions and D8.Final Meeting.

This method could be seen as it can trigger firefighting and maybe be a barrier to succeed with Six Sigma. As can be seen in the example above this method treat root causes after the symptoms have been treated. In 8D Contamination of action comes before Cause and Effect Analysis in Six Sigma it is the reverse order. This can maybe cause some problems. Though the company has used 8D for a long time and it is deep rooted. There is maybe a risk that people will think 8D when they think they are doing Six Sigma.

5.3 Six Sigma

Bosch Rexroth Bethlehem is a plant with multinational employees where the majority are American and German. According to VP, the main reason that Bosch Rexroth Bethlehem uses Six Sigma is that he sees it as a powerful instrument for complex problems, and that it is a possible program for CI processes. The way that the Bosch cooperation has defined how successful they are at Six Sigma is by how many employees they educate. All interviewees agreed that this is a substandard way of defining success of Six Sigma use. According to a company manager, it is stated that 1,5% of the employees should be active Belts locally, in order to meet the Central Directive; this decision is made on corporate level in Germany. However, on what level Six Sigma is implemented is not decided in Germany. According to one senior engineer, there are no requirements for how many projects that are to be started or finished, and as it is right now, management is glad if there are projects running. However, if the decision to work with Six Sigma is not followed, there will be people that will be answering questions from corporate level as to why the plant does not apply Six Sigma. According to one employee there is a lot of politics involved in organizations of today, and it can be hard to change or remove things that are not working as wished, even if it could be seen as a waste of resources to keep it as it is.

The Six Sigma program at the Bosch Rexroth Bethlehem plant began in 2008. Before that, the plant used Six Sigma on a small scale, and successfully completed some projects. Since the start of the Six Sigma program at the plant there have been five completed projects the first two years, but the last years there been no completed projects. According to a senior engineer with great knowledge about Six Sigma, the company has a long way to go before it has fully implemented Six Sigma. In 2012, there were Six Sigma projects initiated. According to one manager, he feels that the company has come to a level where they do not get better in their Six Sigma use. He also explained the reason for management wanting the organization to be better, by showing the Kano model which describes that

a company continuously has to develop in order to stay competitive. A top manager stated that it is important to use the capability in the company as efficiently as possible. One manager stated that the plant already was good at its Six Sigma use, but they want to be better; he also stated that one of their advantages was that they had “committed top management”. With this statement he did not define what he meant with commitment it could be either top management committed to growing Six Sigma or that they are committed to using in Six Sigma projects.

5.3.1 Current State

According to one group leader “it is hard to focus on the details when the elementary foundation is missing and not is in place,” as he felt this is the case in the Bethlehem plant. This statement is also strengthened by observations. One observation made was that the organization is lacking a written structure of how to proceed with Six Sigma projects, as well as pre-work from the process owners’ side when a project leader is dedicated to a Six Sigma project, as there does not exist any written text from the process owner about the case. This lack of structure creates confusion when the project leader does not have any background in the field, and makes it hard to define the project scope. Lack of team spirit is also a problem, because of a perception that if a project leader is dedicated to the project, that project leader is the only one who has responsibility to the project. Further, there is a lack of planning as a result of people being involved in Six Sigma projects having several tasks besides the project that require frequent firefighting. On group leader cited Plsek and Onnias “If the problem is vague and unobservable, the same will be true for the solution”, as he felt that this is something that the organization should bear in mind.

The following is a procedure that the organization uses when starting Six Sigma projects (2013-06-27): An employee speaks to the Six Sigma coordinator about an idea for a project. If the project idea is accepted, he or she must specifically ask for a project charter. The company has one light charter, and a more detailed charter. The choice of the charter is up to the applicant, depending on how complex the project is. When the charter is complete, it is given to the steering committee that either rejects or approves the project for resource allocation. Steering committee meetings are supposed to be held every six weeks, but during this six month thesis project, there was only one meeting. This is due to, as one senior engineer described, "it has been a bit chaotic lately". He also stated that the problem usually is to keep resources on the project, and he has felt that "this problem has been happening more and more lately". According to Company Standards, the project sponsor chooses what type of project category that the project will fall into. Project categories are A, B, C and D, where D is the most complex and A is the least complex type of project. This Standard also described that a project team consists of a Project Manager, and nominated associates and consultants; this team has a signed contract between the Project Manager and the control line managers, with the purpose of releasing the individuals involved in the project from daily tasks to work on the project.

5.3.2 End of Project

There were no clear definition in the company, of when a project is formally completed. For one interviewee it was when a project sponsor sign off that it is closed. For another interviewee it is when all the objectives have been completed. One interviewee defined it as when the process that had to be changed have changed. It was also defined by one manager as either one alternative of three, it can either be fizzle out, due to prioritizations, or it can be when defined tasks are done and the project has been wrapped up, or it can be defined by the 20/80 role when you have come a long way towards the predefined goals but decides that remaining parts are unnecessary or too costly to complete. A senior engineer in the company saw it as "when you maintain control over a certain time". Finally the view according to one top manager was that the predefined goals of the project are fulfilled and/ or that the ones involved in the project, mutually review the project and agree that the project is finished. He added that projects need to have an end, to be projects, "but sometime you have to limit the project from the predefined goals".

5.4 Six Sigma

According to one interviewee, many companies and education institutes in the USA do not do any difference between lean and Six Sigma. This concern was strengthen by the description of education of the employee that is under Six Sigma education, as it seemed to only focus on the tools, both for lean and Six Sigma. And one observation that was made during this thesis project is that the company seems to be focusing more on the tools than on the "philosophies" in both Six Sigma and lean production. The management in the company does not have any experience of working with Six Sigma, but some of them have been managers in other companies where Six Sigma has been used and where they have been involved in selecting projects and monitoring Six Sigma projects. All the managers interviewed were generally positive to the use of Six Sigma. The person that have the main responsibility of the program has previous experience of working directly with Six Sigma but is new in the position of being responsible for the program. The view of what Six Sigma is, from different angles in the company can be seen in Table (5.2) below.

Table 5.2: The view of what Six Sigma is from different standpoints in the Bethlehem plant.

Interviewee	Definition
Top Manager	1) Theoretical problem solving instrument for complex problems 2) One more way of continuous improvement. If Six Sigma is used more in many different departments and employees is trained in Six Sigma, employees can solve problems in other areas than there one and it also lead to improvements of the overall processes. It is an methodical tool.
Department Manager	A toolbox consisting of problem solving, statistical and project management tools.
Master Black belt, Senior Quality engineer	Thought process, ordered tool set
Lean specialist	Statistic methodology to isolate variables and statistical validate conclusions within a given confident level.
Project Specialist	Structure way of working to find root causes and find corrections.
Employee under greenbelt education	Methods for evaluation of problems and judging the effectiveness of corrective actions

5.4.1 How the Company Works With Six Sigma

At the Bosch Rexroth Bethlehem plant, the VP working with resources dedication and search for what are the most important things to be solved, but that does not necessary mean that the improvements have to be Six Sigma projects. The Quality manager is the one responsible for having resources available as well as monitoring that the Six Sigma projects moving forward. The Six Sigma coordinator is the main responsible person for selecting what projects to carry out and he also support the project leaders. One observation that was made was that the coordinator does not have the possibility to do the described task of supporting projects in the way required, due to too much firefighting tasks on the side that has taken over the dedicated work time. One observation that was made, was that there did not seem to be any preparation work from the process owners before the project was dedicated to a Black belt. According to a senior engineer a typical Six Sigma project at the Bosch Rexroth Bethlehem plant is conducted as follows. The management provides data to the Black belt, then the Black belt drive the project by breaking down the task into smaller tasks that others can do. The last part the senior engineer felt is a difficult part. And it usually ends up in that the other employees' tasks in the projects are to support the Black belt with data for the project.

According to one interviewee, the BPS department (department for Bosch Production System) is responsible for Lean and QMM (department for Quality Management and Methods) is responsible for Six Sigma. He continued to explain that he usually tries to use lean as far as possible and if that is not enough than he continue with Six Sigma see Figure (5.1). He described Six Sigma as "a really powerful tool but if used when not needed it will be like killing a mosquito with a nuclear bomb, really unnecessary".

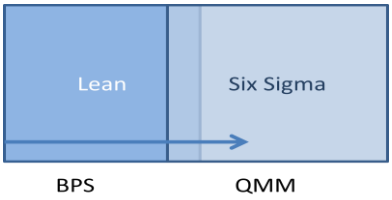


Figure 5.1: How the BPS Department Works With Six Sigma

For one of the interviewees that had less experience of Six Sigma, it was more about working with the different tools and when to use the tools, then a structure way of working. This interviewee saw Six Sigma more as a set of tools then a philosophy. The training that had been conducted by this employee was in Minitab and evaluating problems and was a Greenbelt education. He felt that he had support from the teacher for his project but that he had not needed it as he had plenty of people at the company that had knowledge in Six Sigma that was better to ask. The ones that do the training get their information from the school. They do not get any additional material from the company (if they do not specifically ask for it) and there is no representative from the company that is introducing or talking at the training. As the ones that is dedicated to a project only get the information they ask for, it means that if they do not know what to specific ask for they will not get any information. Concerning milestones, the project leader work in his or her own pace.

5.4.2 Advantages and Disadvantages

One question that was asked to the interviewees was what the interviewees saw as the main advantages and disadvantages of Six Sigma; the answers are summarized in Table 5.3.

Table 5.3 Advantages and Disadvantages of Six Sigma

Advantages	Disadvantages
● Create a better level of confidence, and helps the person working on the project to know what he/she is doing ● It helps peoples breaking down problems into smaller manageable pieces. ● Peoples do not need to be experts on the field were the problem is, in order to solve it with Six Sigma. ● It is sometimes the only way to identify root cause. ● It gives a structure to organize work ● It gives the possibility to get a grasp of complex problems ● It is based on the outcome ● It helps peoples to get right tools in the right order when solving a problem ● It is a methodical problem solving tool. That enables peoples to solve complex problems.	● The method needs large amount of data, and resources to be successful. ● Risk for doing more harm than good, if using the method without knowing it. ● The reputation of Six Sigma can lead to that companies use it because they have heard about the good reputation and want to use it therefore. Without knowing its value. ● The reputation of Six Sigma can lead to that people want to get Six Sigma certificate so that they has a better chance to get a good job somewhere else. ● It is not always the best method to use. ● The tools doses not fit all types of problems ● Too many sophisticate tools some time. ● Increase the complexity of the task sometime. ● Too time consuming if applied on too simple problems.

There were three main areas of strength of Bosch Rexroth Bethlehem's application of Six Sigma that the interviewees pointed out:

1. Management was committed to the use of Six Sigma.
2. Management encourage training in Six Sigma
3. Six Sigma is well known and accepted over the plant

When it comes to the company's weaknesses concerning Six Sigma the main weakness that was pointed out by the interviewees, was the resource allocation. According to the employee that have a project that is on hold, there was a well working team, and the main problem as he saw was that management outside should have been more involved, and feel responsible for the project. As the reason for that the project was put on hold was that there were no budget for the investments needed to improve the process. The people involved feel that the project is important, but there are a lot of other projects that are important at the same time. He continued to explain that the employees will always focus on the project that he/ she get the most crap for not doing, this projects often tend to be the projects that is closest in the future, which make it hard to get projects with long-term goals to be first priority. The employee that is under education, felt that the thing that he were lacking the most, when working on Six Sigma projects, was time. Moreover, the weaknesses that were brought up by the interviewees were:

1. Lack of resources
2. Lack of structure
3. Lack of knowledge

In this case lack of resources was by far the most common mentioned factor of what was seen as the main challenge for the success of the company's Six Sigma use.

Things that defines a organization that is successful in its use of Six Sigma, can according to a BPS member be described as "When the organization successfully completes projects and it gives financial results". An employee that was under education for Six Sigma, saw it more as "When the company is more result focused, and there exists an fluid understanding of how it can be used in the organization. As well as it should be the way the organization approach problems". According to one

employee successful use of Six Sigma is when “the organizations leaders and its employees understand the value and support Six Sigma”. As for the top management it is defined as when “a company that uses Six Sigma not as an purpose end in itself”. One manager involved in the implementation agreed on the previous statement by defining the definition as, “when there exists an understanding when and how to use Six Sigma, more than number of projects or belts conducted. It can also lead to the insight that the Six Sigma should not be used in the company, because of insight that it is not suitable”. The one responsible for the Six Sigma program added to this definition by adding that it is “when the leaders and its employees understands what six sigma is and what it is not. And when there exists a robust project selection process that ranks the benefits of the projects by money, time and feasibility”. As was observed, it is not easy to define what variables and when an organization is successful in its use of Six Sigma, but it seems too easy to know when an organization in not successful in its use of Six Sigma.

The summarized view the relation between Six Sigma and CI from the empirical data is that there does not exist any contradictions between Six Sigma and CI according to interviewees. Six Sigma is necessary for helping the organization to know if the CI’s are moving in the right direction. CI is a daily task and Six Sigma is one way of solving problems and there is more of a connection between them, the a contradiction. More on, Six Sigma can tend to take the edge of the other improvement initiatives. Furthermore, the empirical investigations resulted in some benefits and challenges of Six Sigma that can occur in organizations, as can be seen in Figure 5.2.

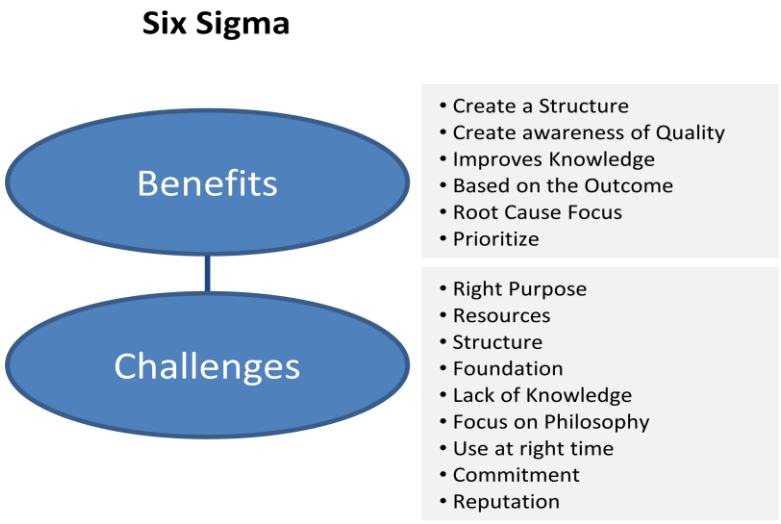


Figure 5.2: Summary of the empirical Benefits and Challenges for Six Sigma.

In Figure 5.2 a summary of the Six Sigma benefits that was found from the empirical data as well as the challenges that was found, are clustered in groups after respective title. In order to get a easy overview of the findings.

6 Analysis and Synthesis

Improvements can be made on a generic level as in CI or in a more focused level such as in Six Sigma. When studying both methods at the same time it can both lead to that the methods strengthen each other, or in some cases weaken each others' opportunities for success. The structure in this chapter is built upon the areas of benefits and challenges that were found in the Theory for Six Sigma. Then these areas were analyzed in relation to the CI benefits and challenges. Some of the strengthening or weakening arguments that are under one heading could also be effecting another area as well.

Figure 6.1 show the benefits and challenges that were found in theory and in the empirical data both for Six Sigma and for CI. As also can be seen in the figure, is that there are two benefits and two challenges that occur both in theory and in empirical data for Six Sigma.

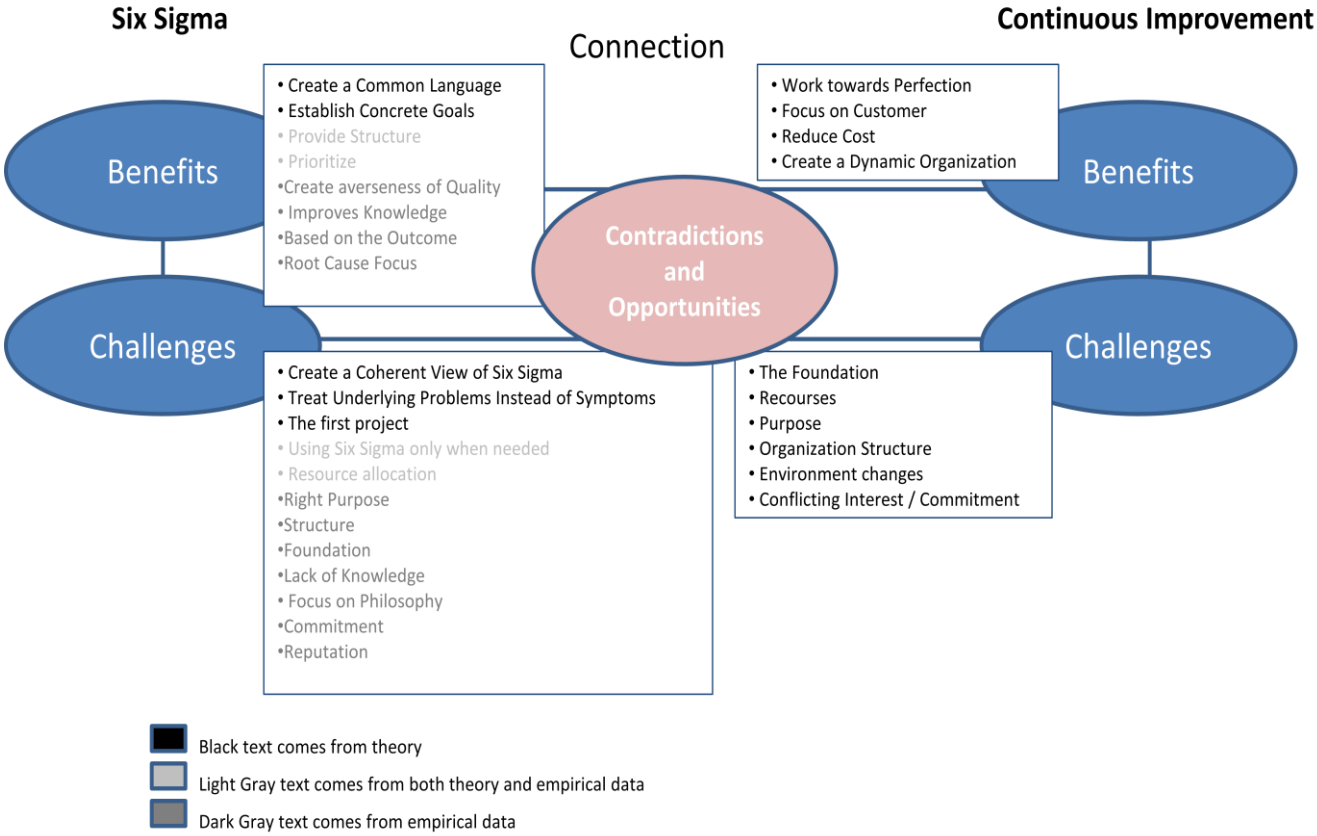


Figure 6.1: Summary of what is in focus for the Analysis

6.1 The Connection between Six Sigma and Continuous Improvements

There exist several ways of how to structure the connection between Six Sigma and CI. In this study it is built upon the areas of benefits and challenges that were found in the theory for Six Sigma. Than these areas were analyzed in relation to the CI's benefits and challenges. Some of the strengthening or weakening arguments that are under one heading could also be effecting another area as well, are not described under every area to avoid repeating facts.

6.1.1 Provide structure

One advantage of CI is continuous work towards perfection (Dean and Bowen, 1994), this can be strengthened by Six Sigma's structure and projects, in the way that the CIs benefit will work for improving the way the structure is implemented in the organization. In the end the right people gets involved at right time in the project (Schroeder et. al., 2008) to a higher extent for every new project. This is something that can be of use as one of the interviewees stated that he felt "that there were a lack of clear directions of when to use what and who is responsible for what in the organizations Six Sigma projects". Hence, Six Sigma implementation and adoption itself would need to be improved in the organization.

The CI benefit of focus on the customer (Dean and Bowen, 1994), can strengthen the benefit of Six Sigma DMAIC that serves to improve efficiency on the chosen improvement projects (Eckes, 2003), so that things that increases the value for the customer, become in focus for the Six Sigma projects.

It is a risk that the structure that Six Sigma provides to the organization decreases the chance of CI success. As Six Sigma will provide the organization with one more way of standardizing and controlling the work (Schroeder et. al., 2008), there will be one more standardization and controlling method that according to McKee (2009) is something that can make improvements take longer time. One of the interviewees, felt that Six Sigma is time consuming, and as observed there are a lot of standardized work that has to be done before getting forward with a Six Sigma project. For example just to get the projects accepted and started, there has to be steering committee meetings, and when the people involved in the steering committee' meeting are occupied in other tasks, the projects will be delayed and suffering. More on, when a project starts to have too many root causes the project is divided into several sub projects and the structured plan will not be followed. There will be one project that after a while becomes e.g. is for example 20 smaller projects with the same start time, and there will be a problem to prioritize between the smaller project, when the resources will not be enough for all the sub projects.

6.1.2 Prioritize

The Six Sigma benefit of using metrics helps organizations to ensure focus on the customer thought the improvement process (Schroeder et. al., 2008). This fits well together with CIs benefit of focus on customer by focus on what the customer needs (Dean and Bowen, 1994). And thereby the approaches can strengthen each other to ensure that the organization can meet customer demands to a higher extent than if just one method is used by itself. According to one employee "one of the benefits that the organization has gain from the implementation of Six Sigma is an increased awareness of quality". Since the Quality department in the company is responsible for Six Sigma, the departments that have started to use Six Sigma have had to be in contact with the Quality department in a new manner. This has lead to that the people involved that comes from another department than the Quality Department has gained new insight in what the work with quality means. Thanks to this, the awareness of quality has increased in the field of CIs. This is due to that for example the BPS department that is responsible for CI, has increased their understanding of quality thanks to their use of Six Sigma and by that, they can now adapt the CI to fit the customer requires and needs to a even higher extent.

Both Six Sigma and CI have a focus on financial benefits (Bhuiyan and Baghel, 2005); (Rose, 2005) and can support each other by helping the organization to look at the financial aspect from different angles. Were CI focus on reducing cost (Rose, 2005) in a general manner and on daily bases, Six Sigma sees it from the view of what financial benefits the project can provide for the organization (Bhuiyan and Baghel, 2005), and then prioritize what improvements that are most profitable for the organization to solve, in order to reduce cost. So in this sense Sigma can contribute to CI by prioritize what improvements that are most profitable to use the limited resources for. And CI support Six Sigma in the manner that it gives the method a holistic view and a way of eliminating waste on a daily base to adapt and optimize the cost reduction in an environment that is constantly changing.

The CI challenge of an unclear objectives and lack of strategy of the use of CI, can make it difficult to identify which improvement effort to prioritize (McKee, 2009). This is something that can effect Six Sigma negatively, as Six Sigma is based on financial data (Bhuiyan and Baghel, 2005), there is a risk when there is a lack of clarity, that the financial data gets bad, which will lead to that wrong projects get chosen. This is enhanced by the interviewee statement that “it is hard to use Six Sigma without a foundation, such as written structure and pre work from process owner”. It was observed that several Six Sigma projects did not get prioritized as it always came up other projects that were more important. That can be an indication that the prioritized financial data is not the correct prioritized ones.

Six Sigma benefit of helping organizations to prioritize (Bhuiyan and Baghel, 2005), is something that can decrease a challenge of CI. By overcoming the CI challenges of having lack of resources that can occur if the scope of the CI is larger than the available resources such as availability and skill (McKee, 2009). It will not help CI by increase the resources, but Six Sigma can help in the sense that Six Sigma can help the organization to prioritize how the resources is best used, in order to prioritize the most important tasks for respective available resources and were the different skills are best suited.

It was observed that, the steering committee meetings that were supposed to among all, have the purpose to prioritize projects were not held as frequently as decided. Consequently it was hard for the organization to prioritize the projects to the limited recourses as effective as was wished for.

The Six Sigma benefit of helping the organization to prioritize (Bhuiyan and Baghel, 2005) can also strengthen CI. When the CI project is an attempt to resolve issues that does not exist (McKee, 2009), the Six Sigma method can help the organization to focus on the root causes for the problem, and help the organization to see what is important and to put focus on that. This is something that is done in the Define phase, and as observed something that the organization can put more effort on, as it will help the organization to focus the limited resources on the most prioritized tasks. As one employee described, it feels heavy and uninspiring to focus on detailed work, when the basic structure is not there. The Six Sigma benefit of helping the organization to prioritize (Bhuiyan and Baghel, 2005) can also that decrease conflicting interest. The CI challenge of conflicting interest such as if the stakeholder does not support the CI effort, if there is exists a collaboration problem between multiple stakeholders, or if the feedback and participation is poor or, when the engagement from the employees is weak concerning the CI efforts (McKee, 2009) can be decreased by the Six Sigma prioritization, as it helps the organization to go back to what is important and help people to create a common prioritization. Also the commitment that sometimes can be a challenge for CI (McKee, 2009)

can be strengthen by the Six Sigma prioritization, as everybody gets a strict clear line to work along and to commit to that has been agreed by everyone. This is reinforced by the interviewee statement that “Six Sigma creates a better level of confidence, and helps the person working on the project to know what he/she is doing”. As was observed a clearer prioritization could have helped employees to motivate for their managers when there were pressure to reprioritize work, why they not should reprioritize in some cases.

6.1.3 Common language

One Six Sigma benefit is that it creates a common language, or terminology (Schroeder et. al., 2008). So when employees with different backgrounds have to communicate they have a language and a structured methodology that create a common understanding of the same case. The common language can strengthen CI. As one of the CI benefits are to increasing the employees’ ability to Commits and constant try to find better ways to do tasks (Dean and Bowen, 1994). The common language can strengthen CI by increasing the understanding between the employees faster and to a higher extent than without the common language. This is enhanced be one interviewee that stated that “Six Sigma improves the overall process and increase the knowledge in the organization”.

The CI challenge when there is a weak foundation that includes ineffective metrics (McKee, 2009) can be decreased by Six Sigma. As Six Sigma can create a common language throughout the organization (Schroeder et. al., 2008), it can increase the awareness of that the metrics are ineffective, and have to be changed. The common language might even help the organization to prevent or decrease the risk that the metrics get ineffective. As the common language increases the understanding between peoples, so that the metrics gets better understood by everyone involved concerning the metrics.

A common language can increase the opportunities for changes and support that these are implemented faster. As when employees’ gets ideas of improvements that leads to changes, they can get the ideas through faster, in the cases when the improvement is concerning other groups of people that without Six Sigma would not “speak” the same language as the person that have the idea. This because there will be less misunderstandings and people not run over, when there is time given for creating a coherent picture of the problem that everybody agrees upon. It was observed that the organization put a lot of monetary resources on educating employees, with the idea that it will create a stronger common language through the organization. According to one interviewee, it takes time before the results of the Six Sigma education will be seen, but he had a strong belief that it will affect the company in a positive manner.

6.1.4 Establish concrete goals

By using Six Sigma the project teams get challenging and specific goals which has proven to give better results than vague non-quantitative goals (Locke and Latham 1990). A benefit of CI on the other hand is that it can help employees to commit to constantly trying to find better ways to do tasks (Dean and Bowen, 1994). This will work even better when employees know what goals that they are working with. As was observed, there exist several improvement initiatives for continuous improvements in the organization, but it seems to be a lack of commitment to the initiatives, as many employees does not sees any concrete goal with implementing another initiative, as they most of the time think that if there is something that they wants to improve they do it directly, without the help of the improvement initiatives.

The Six Sigma benefit of establish concrete goal (Locke and Latham 1990), collaborates well with the dynamic organization. As CI create a dynamic organization (Rose, 2005), the methods will strengthen each other in the sense that CI provides the organization with the ability to constantly improve to meet dynamic needs and requirements, and help the organization to develop new processes, technologies and products (Rose, 2005), that in turn strengthen the organizations ability to have concrete goals that is up to date and adapted to the dynamic environment. And the concrete goals will help organization to improve the possibility to specify the dynamic requirements so that the employees gets tasks that are challenging and up to date that in the end results in higher commitment and better results. One way of establish the concrete goals by using Six Sigma is to break down problems into manageable pieces as was stated by an interviewee. This should be done in the Define phase, but as was discussed with an employee that was struggling with his Six Sigma project, it is also important to be aware that a problem that has been defined and divided into what as from the beginning seemed to be managerial, can after the search for the root cause end up to have to many variables that can be potential root causes. This will lead to that the project has to be redefined and divided into sub project, due to the fact that Six Sigma works best when focusing on details and cannot solve to big problems at one time. In such cases it is important to know how to handle the situation of breaking up a project into smaller sub projects.

6.1.5 Create a coherent view of Six Sigma

As there is diversity between different Six Sigma definitions both in theory and in organizations (Hahn et al. 1999; Schroeder et. al., 2008), CI can strengthen Six Sigma by constantly trying to create a coherent view of Six Sigma for the specific organization. A weak foundation such as if the objectives of the CI effort are unclear or if there is a lack of strategy of the use of CI or as, when there is difficulties to identify witch improvement effort to prioritize on (McKeen, 2009), is something that can make the challenge for Six Sigma success harder. One Six Sigma challenge that can exist is diversity between different Six Sigma definitions in organizations, which makes it hard to create a coherent view of Six Sigma (Hahn et al. 1999; Schroeder et. al., 2008). The weak foundation can make it more unclear what definition the organization stands for and how to work with Six Sigma. In the organization it was observed that there exists several definitions on Six Sigma. Further there were different news on when the organization has success with Six Sigma e.g. the amount of Six Sigma educated employees, how many active belts there were, or how many completed projects they had done within a year.

6.1.6 Treat underlying problems instead of symptoms

One Six Sigma challenge is to make sure that the ones working with Six Sigma treat underlying problems instead of symptoms (Linderman et al., 2003). This challenge has some similarities with McKee's (2009) CI challenge of resolving issues that does not exist. The challenges are similar to each other in the sense that they will both lead to that the focus will be on the wrong place, and the root to the important problems in the organization will not be treated which will lead to that the important problems will remain. The Six Sigma challenge will just solve a problem for the moment and will lead to a circle of firefighting and the CI challenge will lead to unnecessary work that takes resources form the value creating work.

One interviewee stated that, "It is a challenge to avoid that the purpose of using Six Sigma gets wrong, when it gets used because it is an order, it will then also be hard to get employee commitment to the project". This statement indicates both that there can exist conflicting interests to why Six Sigma is used in a organization and that it can lead to consequences that "wrong" things gets treated. By that there is a risk that the CI challenge of conflicting interest (McKee, 2009), can decrease the success of Six Sigma. As the Six Sigma challenge of risk of treating underlying problems instead of symptoms (Linderman et al., 2003) can be larger when there exists conflicting interests that comes from for example higher hierarchies that have the power to "drive" over the knowledge and structured decisions. Though the company has used 8D for a long time and it is deep rooted. There is maybe a risk that people will thinking 8D when they think they are doing Six Sigma. Though the Contamination of action in 8D comes before Cause and Effect Analysis and in Six Sigma it is the reverse order. This can maybe cause some problems.

6.1.7 Using Six Sigma only when needed

Sometimes there can be problems when using Six Sigma, such as when there is a wish to use the method a belief that Six Sigma is the solution for everything, it can also lead to that wrong people gets involved (Goh, 2002). This can for example occur when as observed there is a pressure from above that a certain amount of Six Sigma projects should be running in order to fit organizational targets. The CI benefit of striving towards perfection (Dean and Bowen, 1994) is something that can strengthen the use of Six Sigma in this manner. As there will be a natural strive towards only using Six Sigma when it is suited. And by that, avoid using the method when it is not suited, as well as avoid that wrong people use it. As the thought of only using methods when they are suited, will be in line with CI philosophy of eliminating waste.

The CI benefit of reducing cost (Rose, 2005) strengthens the management's view, that Six Sigma should be used only when it is needed, since Six Sigma require large amount of resources, and as one interviewee stated, Six Sigma is time consuming. In this sense CI will strengthen Six Sigma, as it is important to be aware when and who that should use Six Sigma in order to get the most profit out of the method and the least cost of it. As for example, the organization has put a lot of money on educating employees in order to increase the common language through the organization. This is good, but as there does not exist any awards for those that gets the education and as it does not seem be needed any other qualifications to be educated than that the employee show a interest to do the education. there is a risk that they lose employees to other organizations. Here the CI could be strengthen Six Sigma by seeing when there is enough educated employees compare with what the organization would gain if they put the recourse on finish off Six Sigma projects instead. As "too

many" educated employees cannot be utilized compared to the monetary recourses, that will be waste, and could even lead to a risk that the belts leave for a competitor.

6.1.8 Resource allocation

The CI benefit of reducing cost (Rose, 2005) is something that can make it harder for Six Sigma to be successful, as there is a risk to take shortcuts to save resources. According to one interviewee "A low price still has its price", and as another interviewee stated "There is a lot of data that is needed in order to solve problems with the method, and that amount of data have a price. Also the people that have this data often are very busy". As on interviewee stated "it is a challenge to keep the dedicated resources to the project", which also is reinforced by the interviewee statement that "it is challenging to manage Six Sigma when it is just added to the already existing work load". In the end there can be a risk that something that from a CI perspective looks like something that will save cost is something that can be more expensive then not doing anything at all. It is a Six Sigma challenge that management do not want to invest a significant number of full-time improvement specialists, instead they assign the improvement tasks to already overloaded employees to deal with it as part time tasks (Schroeder et. al., 2008). There is a risk when employees does not get any awards for the Six Sigma training, the only incentive they have for doing the Six Sigma training, is to be able to put it on their CV and search for a job somewhere else.

As was observed, resources were taken away from the Six Sigma projects several times. That can have its explanation in that the strategy of how the Six Sigma method should done is not totally thought through. A weak foundation is something that can effect CI negative (McKee, 2009), but it can also effect the use of Six Sigma in a negative manner, as it risk to get the resource allocation to be wrong (too little people or wrong people at one place and too many in another place). This can occur when the objectives of the CI effort are unclear or if there is a lack of strategy of the use of CI or as, when there difficult to identify witch improvement effort to prioritize on. This can create confusion on what and how the organization should use its resources.

6.1.9 The first project

The CI benefit of working towards perfection (Dean and Bowen, 1994), strengthening the possibilities to complete the first Six Sigma project and to work to build up a strategy and foundation to make the next project better. By this CI will counteract the challenge of being delayed, or even unsuccessful, in completing the first project (Eckes, 2003).

The focus on cost reduction in CI (Rosen, 2005), risks to effect the possibilities to finish of the first project in a desirable manner. The Six Sigma use might be suffering, as there will be a risk that the resources will be relocated or insufficient. The first project is important for the organization in the sense that it show that the method is possible to use in the organization, and when it takes to long time ore if the first project does not end up successful there is a risk that there will be a lack of commitment and belief for the method (Eckes, 2003). It was observed that a Six Sigma project were put on hold for several years due to that the improvements that were needed for moving forward were not prioritized. This lead to a lack of commitment to the project, if the method is suitable for the organization and that people involved in the team had moved forward to posts.

If there are conflicting interest or lack of commitment (McKee, 2009), it will lead to big problem to finish the first Six Sigma project. This as there is a risk that there will be too many directions that employees and mangers wants to work against. In the end there will be a risk that the trust for the Six Sigma method will be suffering. It was observed that people that were dedicated to one Six Sigma project and that did not work at the Quality department thought that there were the people involved in the project that came from the Quality department that had the responsibility to move the project forward. They also most often thought that the ones that do not come from the Quality department, has as there only responsibility for the project, to give the Quality department people involved materials. Unfortunately, the ones that did not come from the Quality department did most often not feel any responsibility for the success of the project. In this case there were also conflicting interests of where the peoples should dedicate their time too, as they already are overloaded. These challenges gave the project hard time move forward and the commitment to the project deceased along the time.

7 Discussion

The purpose of this study *is to explore how Six Sigma can be related to continuous improvement work at a manufacturing plant, as well as to understand challenges and possibilities in using Six Sigma as a part of a continuous improvement initiative.*

7.1 R1. In what ways can Six Sigma and continuous improvement initiatives be linked?

The tools and techniques in Six Sigma are similar to prior QM approaches, but as it provides an organizational structure, it helps organizations to better control process improvement activities, and creates a common language that enables exchange between organizational members with different backgrounds (Schroeder et al., 2008). This common language was at the company a main reason for using Six Sigma. To make it possible to create the common language that Six Sigma can contribute with, it requires that the Six Sigma philosophy gets integrated in the whole organization (Scott, 2001). That is why the company invests a large amount of resources to educate employees.

7.1.1 The relation between Six Sigma and Continuous Improvements

This study contributed to the scientific research in the field of Six Sigma by pointing out variables that either can simplify or hinder the implementation of Six Sigma. That according to Parast (2010) is something that is in need of research. According to the interviews there is no contradictions between CIs and Six Sigma, in the circumstances that the persons involved knows what they are doing (BPS employee), and this statement strengthened by Assarlind et al. (2013) who conducted a similar study. According to the VP CIs are many small steps rather than a few big ones, which according (Bhuiyan and Baghel, 2005) is the most common way of working with CI; in comparison to Six Sigma that the VP describes is more about putting a lot of resources on one big thing. He continued to explain that the risk that can occur with Six Sigma is that things are made bigger than they should be. This was also observed in the beginning of the internship, as the observed projects pre-work was not sufficient. The define phase became longer than necessary in one project, as the project was not suited for Six Sigma in the sense of analyzing data and that it more was a case that they wanted the project to be done.

For one top manager Six Sigma can be describe as big and slow in comparison to CI that he describes as small and fast. Another interviewee saw Six Sigma as a necessary thing to help the company to know if the CI's are moving in the right direction. Two of the interviewee saw CI as a daily task, and one of them continued to explain that Six Sigma in this case is one way of solving problems and that there is more of a connection between Six Sigma and CI than a contradiction, which also another interviewee agreed upon, which is strengthened by Assarlind et al., 2013). There seems to be several times were the Six Sigma benefit can strengthen the CI benefits and vice versa, as well as they can decrease each other's challenges. But in some cases the benefit of one method can increase the risk for the other method to fail. Such as that the structure that Six Sigma can contribute to a situation when it is harder for improvements to be made in an easy way. And that the CI benefit of reducing cost can lead to that the Six Sigma projects gets suffering due to that shortcuts are made to save resources.

Can there be too many improvement initiatives at the same time? And can it lead to that the Six Sigma use gets suffering? As observed, the company use several different improvement methods, which are suited for different type of improvements, some of the methods mentioned were the Bright Ideas program, Suggestion cards Program, Six Sigma Program, CIP (Continuous Improvement Processes), PDCA, Training, Effective meeting training, Workshop in improvements and 8D. It can give the impression of that the company wants too many things at the same time, and does not have the ability to prioritize for what improvements the limited resources should be used. As one employee stated, there is hard to work on the details when there is a lack of foundation. In the case of prioritization, it can be seen as the lack of foundation is a lack of clear rules of how to prioritize within the Six Sigma initiative.

7.1.2 The Effect of Six Sigma on Other Improvement Initiatives

According to Foster (2007) the effects of Six Sigma in organizations over time is something that is a field that is of need for more investigation, and in this sense this study contributes to the scientific research of Six Sigma.

One problem that an interviewee stated was that Six Sigma is often combined with lean in many Six Sigma educations and companies in the USA, which sometimes results in people using lean or lean tools thinking that they use Six Sigma. The good thing with Six Sigma according to one interviewee is that it has raised awareness of quality in the organization. According to one interviewee Six Sigma in one way took the edge of the other improvements initiatives. Which, he continued led to that they do not use small tool on big problems anymore. But one observation that was made, was that they sometimes seem to have problem with that they use big tools on small problems instead, which lead to waste of resources and according to Goh (2002) and Tatham and Mackertich (2003) limit the numbers of successful projects. Moreover, one interviewee sees that Six Sigma has contributed, by adding one more tool set and more knowledge to organizations that choose to use it. According to the VP it is still hard to know what Six Sigma has contributed wide to the plant, but with training among employees it gives better methodic and understand of problems before they gets to the solution. He also sees that Six Sigma Improves the overall process and increase the knowledge in the company, as supported by Schroeder et al. (2008).

According to the Quality Manager the quality department uses the problem solving method 8D and has done so for a long time. This method is one way of working with CI, which the Quality manager seem to prefer before Six Sigma. One observation that was made when comparing Six Sigma and 8D was that there are quite the same, but that root cause analysis are done in different order (Figure 7.1). In Six Sigma the root cause analysis is made in the beginning and in 8D it is done in the end. It seems that there are both good methods but should be used at different occasions; there could however be a concern that the mindset of 8D can affect the use of Six Sigma.

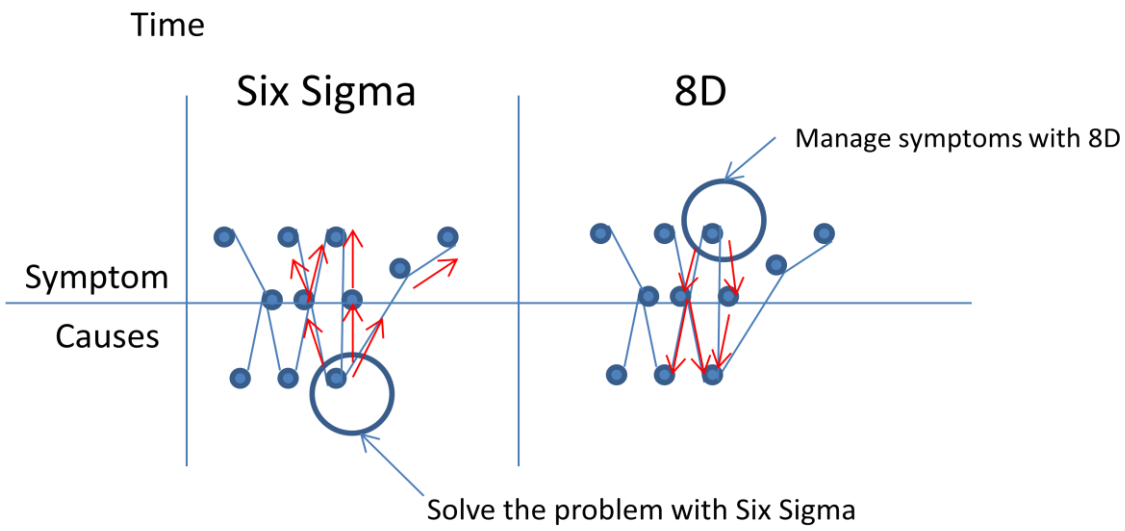


Figure 7.1: Differences of Solving Problems with Six Sigma and 8D

As can be seen in Figure 7.1, at the first glance looks equal. However, in an organization were the resources are limited, there is a risk that the 8D problem solving method ends by just only solving the severe symptom for the moment. Than the same symptoms risk to be solved several times. Also as the 8D method focus on begin at the symptom there can maybe increase the challenge that can occur when using Six Sigma that the project team wants to jump directly to solve the problem and have a hard time to focus on the define phase, as have been described by Schroeder et al. (2008).

It feels as there is a difference in the mindset between Six Sigma and 8D in the sense that for 8D there is a problem that emerged, the problem/ symptom will be solved and after that the problem solving team identify what was causing the problem that was solved. This is probably a good method for handling acute problems up. Six Sigma on the other hand is more philosophic in its nature (Markarian, 2004; Eckes, 2003). When using the method, the first step after defining the problem is to see what the root of the problem is and solve the root of the problem instead of the symptom (Eckes, 2003). In this sense, as was observed, Six Sigma would not be good when handling tasks such as if something just have to be fixed, as it will tend to lead to that too much time spent on wrong things.

The 8D that was described can be seen as fire fighting mentality and should be used only when firefighting problems occur. But one problem that was observed was that the organization seemed to use it most of the time, and there did not seem to be time for preventive work. This way of working seems to lead to a lack treating root causes and handle lesson learned. As there will be low incentives for finding the root causes when the symptoms are treated and when there are several more fires to handle.

7.2 R2. How can Six Sigma be continuously improved?

There is a need for more scientific research in the field of Six Sigma (Schroeder et.al, 2008), which this study has contributed by discussing how Six Sigma can be continuously improved. According to all interviewees the top management is committed to Six Sigma which is in line with Eckes (2003). This statement leads to the questions: what is meant by being good at Six Sigma and what is it that the company actually wants? There was one vague answer to the latter of the two questions: that

the company wants to “be deeper” in their use of Six Sigma. One group reflection was made that management wants to use Six Sigma, but they have to be aware of that it takes time to use Six Sigma, it requires resources, and how interested is the management of what it is that Six Sigma requires to work? As one manager stated “a low price still has its price”, which is line with Eckes (2003).

7.2.1 Things that Can Improve the Company’s Six Sigma use

According to one of the interviewee, the main thing is to create an understanding of the values that the use of Six Sigma creates and then this value has to be fully supported. As he feels that employees right now, are forced to use Six Sigma but do not get the time and financial support needed to complete it. Also, the plant is a part of a large corporation, and there are many decisions that are made centrally. The last years there have been no completed projects, but there have been several Six Sigma projects that have been started. This is something that can lead to lack of commitment a belief of the method, and it is probably better to focus the resources on finishing one project. In order to have a project that can be used as a role model, and for building the CI for Six Sigma use on. Another thought that was brought to mind was that it is good for the management to investigate ways that the organization can learn from individuals in the best way, as this is something that will increase the speed of the improvements made. Further, the process for how the Six Sigma method is being used probably should gain from increasing the process standardization with clear tollgates as also was mentioned by (Bastien and Hostager, 1988; Weick, 1993).

Another interviewee stated that it is a need for clearly designed applications for the projects, to structure and decrease confusion, and that practical examples or basic training even for people that do direct work with the Six Sigma project, as it will create a basic understanding for the method through the whole company. There were also recommendations from one interviewee that more dedication of time from upper level management is needed, as supported by Eckes (2003). Another interviewee stated that “managers have to be real about the investment and how serious the investments are”. Moreover, it was also mentioned that team mentality has to be improved in the organization. And that one problem is that people does not understand that the Six Sigma projects is not the Quality department’s projects. The Quality department should only be a support to the projects (this was stated by an employee that has been working with Six Sigma in the company and have been working in the company for a long time, but does not work at the quality department). He also mentioned that there is a belief that the persons that think that the quality department is responsible for the project also think that if they are involved in a Six Sigma project they only have the responsibility to sign where needed. He further mentioned that it is not defined who is reporting to whom and who is responsible for what. By increase the collaboration between the BPS and the QMM department and by start seeing Lean production as a philosophy instead of a set of tools, the understanding for how that is responsible for what can be improved as is supported by Assarlind et al. (2013). In this case it is important to increase the awareness of the responsibilities in the Six Sigma projects, so that the project leader in an easier way can break down the problem into smaller managerial tasks that can be assigned by different group members.

According to management, they have started a program that concerns, “what do they need to improve in their Six Sigma use”. One manager believes that there is a need for more coaching of the belts and not just let them handle themselves, as well as see to it that the programs move forward. This was also confirmed by the employee that is under education, he mentioned that it would be of

help to have a brief summary that could describe when to use what. Another person form management stated that the training (education) of Six Sigma is important as well as to carry out projects, share and implement well done projects. He also stated that presentations of projects to the departments' managers also can be a good thing as it will help the department managers to get an understanding for the use.

It was observed that, depending on an individual's position, and or in combination with his or her personality, it can vary how hard or easy that individual will have to get other peoples to do things that he/ she request the other person to do. This indicates that in order to improve the use of Six Sigma it is important to carefully select only the best peoples to educate and lead Six Sigma projects as it according to Snee, (2010), is something that is important for increasing the commitment to the Six Sigma projects, and to help the projects to move forward.

To be able to improve the use of Six Sigma in an organization, it is probably most often a good idea to start with analyzing the foundation that the organization plan to build the method on, as one group leader stated "it is hard to focus on the details when the elementary foundation is missing and not is in place," as he felt this is the case in the Bethlehem plant with can be strengthened by Locke and Lathem (1990). And without the foundation there is a risk that the details will be waste of resources, which goes against the idea of lean production to eliminate waste and it will also go against the 20/80 rule. Some things that has to be thought through concerning the foundation, is if the organization have a proper standardized way of working with the method, and that the method have support from the organizations values, visions, missions and goals, which is in line with Snee (2010). More on it can be investigated how the company handles the step that goes from decided idea of improvement to a project leader. In this step it is recommended to have a written preliminary project chart to handle over to the project leader, which will help the project leader to motivate why the project is important, and why resources should not be taken away.

Finally, it is important for the success of Six Sigma that organizations understands the customers present and future needs, as the true customer need is the root of Six Sigma (Deming, 1986; Deming, 1994). This was something that was brought up by several employees as one opportunity for improvement. By integrating BPS and QMM this is something that can be improved, as the quality department have a good view of what the internal and external customers need, the BPS department can customize the improvement methods to better fit the organization.

7.3 Recommendations for future studies

The recommendations for further studies, is to deeper investigate the relation between 8D and Six Sigma use. As there maybe can be a risk that a organization that is used to use 8D can have a hard time to adapt the reverse order of working that exists in Six Sigma and by that maybe can have a hard time to implement Six Sigma in the organization in a successful way.

It is pointed out in several academic texts about Six Sigma, that it is important for the success of Six Sigma to have committed management. But there are few texts that describe in detail what they mean by this statement. In the empirical studies it was found that there is a lack of awareness of what the statement means, however all interviewees agreed that the main strength of the company was that they had committed management. At the same time they felt that the top management did not allocate enough resources to the use for Six Sigma.

One question that emerged during the observations was, what is the optimum rate of Six Sigma educated employees? This was outside the scope for this study, but can contribute the field of improving organization. It is mentioned in several articles that it is good to have a broad spectrum of employees educated in Six Sigma, to increase the common language within the organization. However, the education is a costly investment, especially when many organizations do not seem to have any reward for employees doing the course more than that they can put it on their CV, which in turn can increase the turnover in the organization. One way to decrease the expensive education can be to increase the amount of “white” belts that gets educated within the organization to increase the knowledge about the method and to decrease the workload of the existing active belts.

8 Conclusions

The purpose of this study *is to explore how Six Sigma can be related to continuous improvement work at a manufacturing plant, as well as to understand challenges and possibilities in using Six Sigma as a part of a continuous improvement initiative.*

The link between Six Sigma and Continuous Improvements

The study shows that there exists links between Six Sigma and CI; Six Sigma and CI can both strengthen and weaken each other with respect to different challenges and benefits. The methods have some shared challenges and some shared benefits.

The structure that Six Sigma can provide to an organization can both be strengthened by CI, but also make it harder for CI to succeed, as standardizations tends to make improvements slower. When focusing on prioritization and customer focus there is a link that shows that Six Sigma and CI strengthen each other. Also the benefit of concrete goals and commitment was something that seemed to be mutual supported. Concerning resource allocation that was mentioned as the main weakness for the organization there is a risk that the focus of CI to reduce cost can increase the challenge of having enough resources allocated to Six Sigma.

The common language that Six Sigma can contribute with something that can strengthen CI by increasing its benefits of committed employees that improve themselves and their environment. Further, it can increase the speed for improvement implementations. More on, it can also strengthen CI when there is a challenge with a weak foundation in the organization, as it can help groups to create a structure by collaborating and pinpoint what is important.

Continuous improvement of Six Sigma

First of all it is important to know the true reason for why the organization is using Six Sigma, in order to know how to improve the use. Sometimes Six Sigma is not suited, for example when the resources are too limited or if there are not enough of repetitive operations that have to be improved, to make the method profitable to use (Goh, 2002). If the method should be improved there has to be an understanding developed, that the Six Sigma projects is not the Quality departments projects, the Quality department should only be a support to the projects. More on, there has to a coherent view within the organization of what is characterizing a successful Six Sigma use. The interviewee answers from this study can in this case work as an inspiration (See Table 5.1). It is also important to continuously have dedication from upper level management, as e.g. managers have to be serious about the investment and their magnitude.

Organizations have to continuously work towards having people that the rest of the team respect and trust and by that only educating the best suited peoples for working with Six Sigma. There has to exist space for coaching active belts, as well as to see to it that the programs move forward. Further, the organization should improve how they handle lessons learned, in order to become a learning organization, and standardize processes as well as having a control plan for the process before the standardizations gets to action.

Finally, it is suggested to review the amount of improvement tools and methods; do an honest validation. The improvement tools and methods can be good and fill a purpose and still not be worth the efforts and resources. The risk is that faith and trust for the methods and tools will decline and in turn hurt future improvement initiatives. It should also be considered, why the different improvements are done, what is the purpose, for whom is it done, who is the customer and has the customer actually required it. In this case the customers can also be internal such as e.g. employees in the sense that it can improve their work environment.

9 Managerial Implications

In this chapter, suggestions of improvements are given to the organization, that can help improving their Six Sigma use.

9.1.1 Projects

It is important for the success of Six Sigma project that there exists real examples, as they will lead to increase motivation and learning (Hoerl, 2001). The examples should show beginning to end processes that illustrate the overall flow of the DMAIC process as well as how the individual tools can be integrated in the improvement process (Hoerl, 2001). And the case examples should be as close to the projects as possible. That is why it should be of focus to completing one project successfully, as this will be working as a good example of that Six Sigma is working in the organization, as well as that it will serve as a guiding example for following projects, that can use the completed project's lessons learned to improve the implementation of the method (Eckes, 2003). This can be one way of improving the lessons learned within the organization. Moreover, it is also recommended to motivate each tool that can be used in Six Sigma with an example of how it has been used in similar areas (Hoerl, 2001), this can be done by further build on to the folder toolbox that was given to the company.

9.1.2 Training

Basic training for the ones that is working directly in the projects is suggested, in order to create a basic understanding for the method throughout the company. As well as more coaching of the belts and not just let them handle them self, as well as see so that the programs move forward. Furthermore, it is recommended to have a representative from top Management that is speaking at the first and last lesson of the Six Sigma course. Describing what is expecting from the once that is doing the education how the top management will contribute and what the goals are with the training and with Six Sigma in the company as well as a opportunity for the once that do the educations and the management to exchange questions and answers. This Management presentation will also contribute in the sense that it will create commitment and trust and inspiration from the employees, to feel a genuine support.

9.1.3 Collaboration

The company it is recommended to further look into the collaboration between BPS and QMM. This to increase the understanding that the Six Sigma projects is not the Quality departments projects, the Quality department should only be a support to the projects. It is also suggested that the organization only have people that the rest of the team respect and trust (the best in the organization) doing Six Sigma, as this keeps it easier to get the rest of the team committed. And by that the team mentality of having several team members feeling responsibility for the project, (not only the project leader) also has an ability to be improved within the organization.

9.1.4 Structure

It is recommended to better define what successful Six Sigma use is, in order to be able to create sub-goals toward success. Moreover, it was mentioned that it is not defined who is reporting to whom and who is responsible for what, which would be a good thing to define to minimize confusion

of responsibilities and to easier get projects to move forward. It is also recommended to increase the standardization of processes within Six Sigma as well as to have a control plan for the projects before the standardizations of results are structured. Furthermore, there can a good idea to use a standardized way to handle how to continue a project when the project leader has left the department.

9.1.5 Prioritize

The organization is suggested to look over the amount of improvement tools and methods. Do an honest validation. The improvement tools and methods can be good and filling a purpose and still not be worth the efforts and resources that is needed. The risk is that faith and trust for the methods and tools will decline and that in turn will hurt future improvement initiatives. There should also be a thought into, why the different improvements are don, what is the purpose, for whom is it done, how is the customer and has the customer actually required it or need it. In this case the customers can also be internals such as for example employees in the sense that it can improve their work environment. As it maybe should not be that many improvement methods used. Finally, it is recommended that the dedication of time from upper level management gets increased, and that managers have to be real about the investment and how serious the investments are.

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Appendix A: Description of terms

Ambidextrous = When the organization can switch between a Mechanistic way of working and a organic working methodology in a smooth way depending on what is best suited for the moment (Schroedera et al. , 2007).

Effectiveness =" is the degree to which an organization meets and exceeds the needs and requirements of its customers" (Eckes, 2003)

Efficiency = "is the resources consumed in achieving effectiveness" and usually refers to the time, cost, labor, or value involved in being effective (Eckes, 2003)

Mechanistic = 1. Mechanically determined. 2. Philosophy of or relating to the philosophy of mechanism, especially tending to explain phenomena only by reference to physical or biological causes. 3. Automatic and impersonal; mechanical. (Houghton Mifflin Company, 2009).

Organic = flexible and value external knowledge (Burns and Stalker, 1961).

BPS = Bosch Production System = Bosch Rexroth Bethlehem's Lean department.

QMM = Quality Management and Methods = Bosch Rexroth Bethlehem's Quality department.

Appendix B: Success factors for Six Sigma (Goldstein, 2001)

No	Success factors	Description
1	**Deployment Plan**	To build a foundation for the structure. Express the need of the structure and that it is implemented from the top of the organization towards and then downwards. The deployment should be detailed, in order to give the organization the infrastructure, training, communication and reward that are needed.
2	**Active participation from the senior executives**	This is due to that no major initiative survives for a longer time without the support and commitment from the senior leaders. This factor not only includes approving of expenditures and assign people to tasks. It also involves establishing clear goals that enabling the cost reduction target, defect reduction target and time framework for task to be targeted. More on, the Senior executive should participate in training that help the to participate intelligently in an project review. They should also participate in all start and closure of each Six Sigma training for the organization, as this will be a good way to energize the participants and clarify the expectations. This participation will also be a good opportunity for answering questions concerning the subject, that can be a way of continuously improving. It is important that the senior managers is a visible part of the program, and to bear in mind that no one else can replace this part.
3	**Project review**	. By reviewing the projects on regularly bases, it creates a constant stable pressure on the Black and green belts to lead the project towards successful competition. The review also helps the senior management to understand what the belts sees as barriers for progress. As this barriers can be thing such as manpower or organizational issues.
4	**Technical support**	This is the task for the Master Black belt. There is not unusual that programs ends as a result of that the front line people runs into barriers or roadblocks caused by technical issues they do not fully understand. That is why MBB should have meetings with the BB on regularly weekly bases, to evaluate the status on the projects. They should look at the approach the teams are using and the result and effort. The amount of MBB should be based on the organizations goals as well as how many BB that has to be supported. The MBB is expected to spend one hour of contact time each week for each BB he/ she is monitoring. The number of black Belts are needed in the organization is determined on the number of projects and place. Where the project and effort should be focused on determine the part to focus at and the size and complexity of the projects will determent the number of projects that is needed.
5	**Full-time vs. Part-time resources**	It is ok to have part time recourse allocation, but then the goals have to be put up after that. There is not a good idea to have aggressive goals if the organization is not prepared to apply the recourses in an aggressive manner.
6	**Training**	. It is not a goal in itself to train people. The training have to contribute with something to the participants, has they are not machines, all input from the training will not be stuck, that is why there has to be right circumstances for the training, so that learning actually occur.
7	**Communication**	There has to be a plan for how the Six Sigma program should be

		communicated throughout the whole organization. The plan should include, What Six Sigma is for the organization, why the organization have chosen to use this method, what the business goals are, what the deployment plan is, how every employee can contribute, training plans, how project gets selected, with projects is under progress and completed, how the business will be benefitting from this method realized to dates and finally communicating the impact it has on different customers. There is a important fact to bear in mind that although the BB will lead the projects, they will need the benefits from employees with area specific knowledge and experience to help the planning and executing the projects.
8	**Project selection**	. A good project for six sigma is one that: that have a measurable impact on "critical to Quality" (CTQ). The responding variables should be easy to measure and there should be a financial benefit of the success of the project. As it can be hard to measure the financical benefits in some ceases it can be recommended to include a person from finance in the project teams in some cases. That data should be easy to collect and the project should have a high probability to be finished. It is suggested that the project should have the ability to be finished within four to six months. It is not recommended that the BB select there on projects as, it is much better that a small task force that have the big picture make the decision. It is important that the correct approach is used in the project and that is why it is good to collect quality data, develop a comprehensive process map that describes the steps that is needed to deliver the process or service, and determine what the cost will be if the quality remains poor.
9	**Project tracking**	help management in the since that it track the cumulative results, alert when projects are getting stuck, help the whole organization to learn by help from information chairing that can accelerate improvement projects and it helps future process owners to get a overview over the organization and history.
10	**Incentive program**	. As it will encourage and motivate people. It is important that only the best is recruited and that there will exist short term rewards, individual as well as team and show that six sigma can increase that chosen peoples career possibility.
11	**Safe environment**	concerning about creating a ***safe environment***
12	**Supplier plan**	
13	**Customer "WOW"**	which indicates that it is good when the company can exceed the customers expectations. And it is a key step in all Six Sigma project improvement efforts to determine what the customer exactly require, to be able to define what the defects are in the form of CTQ (Linderman et al. 2003).

Appendix C: Attributes for Best Practice (Goh, 2002)

1. *Only rely on measurable items*

The team should relay on the things that can be measured.

2. *Repetitive outputs*

The Six Sigma method is suitable for repetitive outputs that has a lack of methodology for innovative or irregular outcomes.

3. *Preventing errors*

Focusing on preventing that error occur instead of creativity or imagination.

4. *Not everything is standardized*

Is to not assume that everything is normal distributed.

5. *Aware of CTQ*

Be aware of the CTQ and that delays can create changes in the where the product or service will end up.

6. *Only focus on current CTQ*

Only study the current CTQ, not the anticipative of technology or social or business changes.

7. *Focus only on a single CTQ*

Focus on a single CTQ for each project instead of multiple CTQ, as it can tend to get to big projects to manage in an effective way.

8. *Focus on organizational learning*

Not focus on individual future knowledge creation during education it is better to focus on the way the organization will learn.

9. *Know when Six Sigma is not suitable*

Know that Six Sigma is unsuitable for creative and interpretive work.

10. *Know what Six Sigma dose not contribute to*

Know that Six Sigma is not constructed to promote intellect, creativity, passion, enterprise or self-renewal.

11. *Focus on the organizations prioritizations*

Work against the organizations prioritizations.

12. *Project teams will be focused on the task*

It is important to be aware of that the project teams will be focusing on internal goals which will not be connected to social missions or responsibilities.