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Master of Business Administration in Marketing Management

Title	Six Sigma at Saab Avitronics – Recommendations for implementation
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Abstract	**Aim:** This study investigates the degree of Six Sigma implementation in the aviation industry where it has been successful and is widely spread. Six Sigma is a quality measurement and improvement program and provides businesses with the tools to improve the capability of their business processes. The paper scrutinizes the possible consequences of implementing Six Sigma in a strictly controlled environment and how the defined success factors for implementation could be interpreted in this context. The concept of Six Sigma is examined with the objective to define recommendations for implementation at Saab Avitronics, a company within the aviation industry. **Method:** The theoretical background presents what theories for Six Sigma successful implementation that are present and seeks to give the topic depth and perspective to establish a basis on which the analysis later is built on. Phases for implementation of improvement programs and success factors for Six Sigma are investigated. To establish the environment in which the theory is adapted the empirical part of the study presents a marketing audit and a SWOT analysis of Saab Avitronics. An internal survey is also performed to examine Saab Avitronics' view on its own knowledge in the area of Six Sigma, improvement methodology, statistics, and the attitudes towards implementing a methodology based on Six Sigma. The analysis is performed by applying the theoretical background in the light of the reality of Saab Avitronics. The possibility of a successful implementation is discussed. **Result & Conclusions:**Continuous improvements are a general prerequisite for survival and success and the study shows that this has also become a requirement imposed on companies within the aviation industry. Although special conditions apply to the aviation industry and Saab Avitronics there is nothing preventing from implementing the improvement concept in general, but special criteria have to be considered when choosing suitable projects. The study concludes with recommendations for Saab Avitronics on five phases for implementation; Plan, Pilot, Implement, Expand and Integrate, and main activities within these phases are defined. Finally the most important success factors for implementation at Saab Avitronics are defined and also how these should be interpreted for continuous improvement and future success. **Suggestions for future research:** The investigation is limited to the aviation industry and to Saab Avitronics. Future research projects could further study the consequences at Saab Avitronics after implementation of Six Sigma, case studies of implementing best practise theories like these recommendations, and studying selection criteria for success factors. **Contribution of the thesis:** The study contributes with recommendations to Saab Avitronics when implementing Six Sigma and also to the know-how and knows-what, to others than Saab Avitronics, when studying the same topic or when planning their own implementation of Six Sigma.
Keywords	Six Sigma, implementing improvements, Six Sigma success factors, recommendations for implementation of Six Sigma, Saab Avitronics

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ABBREVIATIONS AND TERMINOLOGY

BIP	Business Improvement Process An internally developed process (at Saab Avitronics) for performing improvement projects.
Black Belt	A fulltime responsible leader of a team responsible for applying the Six Sigma process.
COP3	Cost Of Poor Quality
Det Norske Veritas	Saab Avitronics' certification body and an independent foundation with the objective of safeguarding life, property, and the environment.
EN 9100:2003	The European standard for quality management systems.
Green Belt	A person who helps leading a Six Sigma team but is assigned on a project or part-time basis.
ISO 9001:2000	The European Association of Aerospace Industries standard for quality management systems.
ISO 14000	The European standard for environmental management systems.
Kaizen	Japanese term that means continuous improvement.
Lean	A structured concept of eliminating all forms of waste and optimize the output of a process.
Minitab	Software tool for statistical process control
Nadcap	A worldwide cooperative program of major companies designed to manage a cost effective consensus approach to special processes and products and provide continual improvement within the aerospace industry.
Fortune 500	An annual list of the 500 largest US companies, published in Fortune magazine.
GRESS	Airbus requirements on their suppliers of airborne equipment.
Part 21	EASA requirements for production of civil aviation products.
Part 145	EASA requirements for maintenance of civil aviation products.
PROPS	A project management model, originally from Ericsson.
ROI	Return On Invested capital.
Six Sigma	A statistically-based process improvement methodology.
TQM	Total Quality Management A movement, an industrial discipline, and a set of techniques for improving the quality of processes.

1 Introduction

This chapter presents the research objective, research questions, and motivation to the study 'Six Sigma at Saab Avitronics – Recommendations for implementation'. Saab Avitronics is presented and the topic is described and helps the reader to understand the background to the research.
The study examines the concept of Six Sigma with the objective to give recommendations for a successful implementation of Six Sigma at Saab Avitronics.

1.1 Saab Avitronics

On Saab Avitronics official webpage (www.saabgroup.com) the following is stated:

Saab Avitronics is one of the leading suppliers of Avionics and Electronic Warfare Systems on the international market. The company offers a full range of Electronic Warfare assets, with focus on systems, equipment and in-service support for self-protection, Electronic Support Measures Systems and Electronic Attack. Key elements are radar and laser sensors as well as jammers, decoys and counter-measures dispenser systems. Complete Electronic Warfare systems are available for airborne, naval and ground vehicle applications.

Saab Avionics range includes airborne mission and utility systems, reconnaissance systems and flight control equipment. Key competence areas are safety critical systems and software, modular avionics, video and graphics processing, digital map systems and sensor integration.

At Saab Avitronics there are some 1200 employees in Sweden (Järfälla, Kista, Linköping and Jönköping) and in South Africa (Centurion, Midrand and Cape Town).

1.2 Six Sigma

Six Sigma is a statistically-based process improvement methodology that aims to reduce defects by identifying and eliminating causes of variation in business processes. Six Sigma stands for Six Standard Deviations from mean. Sigma is the Greek letter used to represent

standard deviation in statistics**.** Six Sigma methodologies provide the techniques and tools to improve the capability and reduce the defects in any process. An important clarification is that Six Sigma measures defect opportunities and not defective products. The more complex a product, the more defect opportunities it has.

Six Sigma aims for processes to be improved, so that problems don't occur, instead of just finding short term solutions to the problems. Finding short term solutions is *improving on the second level of learning* as Richard Normann expressed (2001). Consequently, what organisations should be aiming for is improving on the first level of learning. At its foundation, Six Sigma is teaching everyone in the organisation to become more effective and efficient (Eckes, G. 2003).

The Six Sigma methodology is based on a concept called DMAIC: Define, Measure, Analyze, Improve, and Control, as shown in Figure 1.

Figure 1. The DMAIC wheel (Sandholm, L. 2000).

The process steps in the DMAIC concept are (iSixSigma webpage):

Define the customers, their Critical to Quality (CTQ) issues, and the processes involved.

Measure the performance of the processes involved.

Analyze the data collected and process map to determine root causes of defects and opportunities for improvement.

Improve the target process by designing creative solutions to fix and prevent problems.

Control the improvements to keep the process on the new course.

Some of the key themes of Six Sigma can, according to www.mekongcapital.com (2004), be summarized as follows:

- Continuous focus on the customer's requirements;
- Using measurements and statistics to identify and measure variation in the production process and other business processes;
- Identifying the root causes of problems;
- Emphasis on process improvement to remove variation from the production process or other business processes and therefore lower defects and improve customer satisfaction;
- Pro-active management focusing on problem prevention, continuous improvement and constant striving for perfection;
- Cross-functional collaboration within the organisation; and
- Setting high targets.

'Most important is the result, not which methodology is used', says Lars Sörqvist of Sandholm Associates (August 2007). He states that it is a combination of tools from different concepts that leads to desired results. Six Sigma projects themselves will not be successful without knowledge of the process flows and where the tight sectors are.

Six Sigma does actually not add anything completely new. Most of the tools and methods are "old" and reliable ones. What's new is that all is refined and combined in a balanced way, ambitiously implemented with allocated resources with the aim to deliver results (Sörqvist, L. 2004). Also the level of training required is a new factor. The most important elements of the Six Sigma concept, according to Lars Sörqvist (2004) are presented in Figure 2.

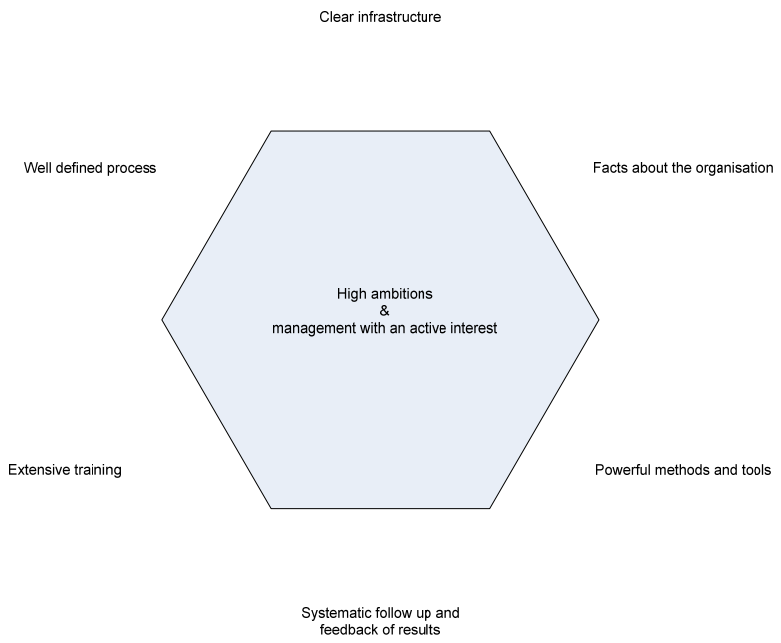

Figure 2. The most important elements of Six Sigma (Sörqvist, L. 2004, interpreted by Köpsén, C. 2007)

Six Sigma is a structured approach to problem-solving within a disciplined, fact-based methodology. The Six Sigma approach focuses on understanding the problem, collecting and analyzing data about the problem, identifying root causes of problems or opportunities, and implementing appropriate solutions. It is a data-driven methodology, i.e., decisions are based on facts and data, not intuition (Williams, K. D. 2007). Dahlgaard and Dahlgaard (2001) argue that Six Sigma and Lean should be seen as a collection of concepts and tools, both with the same objectives supporting the aims of TQM. The Six Sigma tools help to solve problems that are too advanced for the philosophy of Lean and TQM and corresponding tools.

1.3 Background and Motivation of the Study

The study focuses improvement activities at Saab Avitronics, where also all the investigation work is performed. Saab Avitronics is within the aviation industry and as in most businesses the company is in harsh competition. The competition in the avionics industry grows more and more intense. The technical solutions become more

sophisticated. This requires a lot from the company. The products also have to be introduced to the market at high speed, and faster than the competitors. This requires even more. The requirement for the company's growing profit remains and additional to that development of new products are no longer financed by the customer during development, but rather paid at delivery. This means the company has to economize in a different way. It has to find solutions as how to become more effective and efficient.
MRO, the Maintenance-Repair-Overhaul Organisation, is one of those highlighting the key issues facing the worldwide MRO industry (Scottish Enterprise, 2007):

- Cutting costs
- Improving safety
- Increasing quality
- Speeding up turnaround times.

Improving is the focus, but maybe it is more correct not to talk about the improvement activities at a company, but the lack of lasting improvement activities.

Improvement is the act of improving something, changing it for the better to get a condition superior to the previous condition.
In the day-to-day work organisations think they are improving when they are really fixing problems, deleting the symptoms caused by a root-cause they are unable to fix. What they really want to do is to take care of the root-cause making sure it and its symptoms do not bother them ever again. Unfortunately there is often not time to do this. At least that is the feeling and the short-sighted plan. The organisations have ironically not the time to once and for all fix the problem that bothers them again and again. There is so much to do and also, they have to fix that problem – again.

Most organisations are highly ineffective and inefficient, where effectiveness is the ability to meet the requirements and efficiency relates to the amount of resources needed for this level of effectiveness (Collins, J. 2001). They have unhappy customers and loose a lot of money because their processes are not run at optimum.

Six Sigma can help change this. Furthermore, Six Sigma can help on areas where potential savings are great. The methodology improves both effectiveness and efficiency.

Like anything new and hard to immediately grasp, Six Sigma is surrounded with a lot of misconceptions (Bellanca, R. 2003). The resistance to Six Sigma is e.g. towards the higher level of training needed to manage a Six Sigma project, the statistical methods to implement and the structured process to follow. And the main misconception is that all this could rather be done using common sense, as it always has been done. Strangely it is not considered how unsuccessful this approach has been so far. Yet another improvement initiative, like Six Sigma, in the organisation may also be received with a dejected smile (Sörqvist, L. 2004). Some passionate, and maybe newly trained, employee launches a new attempt to improve business. It may also go quite well as long as this single passionate person keeps going, but the initiative is seldom really implemented and it never becomes part of the company culture.

Besides Six Sigma a lot of other techniques are available, and have been the quality fad of the past, e.g. Quality Circles, Total Quality Management, Lean, and Kaizen (Sörqvist, L. 2004). And now the turn has come to Six Sigma. So far Six Sigma has survived and been proven again and again to be the cure for lasting improvement work.

Saab Avitronics could improve customers' satisfaction, but even more improve internal effectiveness and efficiency.
Customer requirements have also now formally come to require more of stable and continuous improving processes and proof thereof. Furthermore customers also require statistical data from their suppliers to be able to predict their own capability.

1.4 Research objectives and research questions

The overall objective of this study is to define recommendations for implementation of Six Sigma at Saab Avitronics.
Planning to define these recommendations is to be compared to planning an internal marketing plan (for implementation of Six Sigma). Consequently, the first question that is studied is: 'How is marketing planning performed?'

The research will then focus on the objectives and related research questions in Table 1 below. Based on this an implementation strategy, recommendations for implementation, for Saab Avitronics is defined.

Research objective	**Research question**
Decide upon the necessity of implementing Six Sigma at Saab Avitronics.	How spread is Six Sigma in the aviation industry?
Define the prerequisites for implementation of Six Sigma at Saab Avitronics.	What prerequisites and possible limitations for implementing Six Sigma and for continuous change are there at Saab Avitronics considering the *special conditions* that apply to the company?
Define a method and recommendations for implementation of Six Sigma.	Which are the phases and success factors for successful implementation of Six Sigma?

Table 1. Research objectives and research questions.

1.5 Scope of the research

The study investigates the degree of Six Sigma implementation in the aviation industry. The result of this is used to plan for implementation on one particular company within the aviation industry - Saab Avitronics.

The scope of the study is limited to implementation of Six Sigma at Saab Avitronics for all of the products and all identified processes.

2 Theory

This chapter presents the theory on the subject. It seeks to give the topic depth and perspective to establish a basis on which the analysis later is built on. An introduction to Continuous Improvements in general (part 2.1) opens the Theory chapter. After that (part 2.2) the process of writing a marketing plan will be discussed. In part 2.3 different strategies for implementation are studied.

2.1 Continuous improvement

Continuous improvement is an ongoing effort to improve products, services or processes.
In the foreword to his book 'Ständiga förbättringar' (2004) Lars Sörqvist writes about mankind's ambition for continuous improvement; the stone age hunter improving his tools and the middle age crafts man improving his workmanship. He states that continuous improvement is a natural part of man.
But what about today's organisations, is continuous improvements a natural part of an organisation? At least the need of improving an organisation is greater than ever before. The competition is harder, customer requirements tougher, the technical innovations are accelerating, and globalisation changes the conditions and the owner's requirement for income from capital increases and becomes more short-sighted. Continuous improvement may not be a natural part or state of an organisation, but it is a required one and a prerequisite for survival and success.

Different improvement concepts have been introduced during the years, become the fad of the year and most usually disappeared after being questioned. The reasons for this are many, but an important one is that the ability to verify and acknowledge the actual good results using these concepts has been poor. The hoped for results fail to be seen because of flawed application and expectations (Sandholm, L. and Sörqvist, L. 2002).

An improvement can be implemented in an area where there is an actual problem or in an area where there is a potential for improvement. What we usually do is to wait until the

outcomes are so bad that anything you do will constitute an improvement (Wheeler, D. J. 2000).

The simplest form of learning is adaptation and correction within a given framework (Normann, R. 2001). This single-loop learning is based on the principle of negative feedback. To really improve we need to get to the second level of learning. We need to make use of positive feedback and question the parameters by which the system operates and by which the intended state has been defined. It implies not only an adjustment within a framework but actually questions the framework itself (Normann, R. 2001).

Barnard, William W. and De Feo, Joseph A. state in the introduction to "Six Sigma – Breakthrough and Beyond" (2004) that all management consists of the essential functions of planning, controlling and improving. This is generally known as the "Juran Trilogy" coined already in 1986 by the Juran Institute. Juran stated that once an organisation carried out these three basic processes, the organisation would have means to sustain a competitive advantage and also survive the future. Maybe Six Sigma is the 'improving' part of this trilogy?

The Juran Trilogy would mean that (Barnard, W.W. and De Feo, J.A. 2004):

- first management set goals and puts in place means to attain those goals (strategic and quality planning).
- then management prevents or corrects unwanted (bad) situations/change (control). This control maintains the (current) standards (way of working), requirements, and specifications.
- finally management creates good change (breakthrough) resulting in improved standards and specifications.

They all interact with each other and individually they are all insufficient. To be successful managers must accomplish all three.

Cost of poor quality, COP3, can be as high as 15-40 percent of costs of goods sold or 15-20 percent of sales revenue (Barnard, W. W. and De Feo, J. A. 2004).

COP3 consists of three major categories (Barnard, W. W. and De Feo, J. A. 2004):

- Appraisal cost – costs associated with discovering deficiencies before external customers do. These activities are performed because we expect to find something bad!
- Internal process failure costs – costs to repair, replace, or discard defective work.
- External product deficiency costs – costs to correct failures that have reach the customer, e.g. repair cost, cost of attempting to regain the customer's confidence.

The chronic level of poor quality (COP3) is planned and it is impossible to do better on average no matter what actions are tried. This chronic level finally becomes the norm and the new standard and built into the budget. In a situation like this improvement is just restoring the (chronic bad) process to the current standard. (Quality) control activities evaluate the performance, compares to the standard and act on a bad difference (a level even worse than the standard). These chronic problems are the candidates for breakthrough improvement. The sporadic problems may be addressed by the control activities.

2.2 Marketing planning

Malcolm Macdonald (2002) suggests that some steps have to be completed to arrive at a marketing plan. Also Jobber, D. and Fahy J. (2002) suggest the same. As this study will contribute to recommendations, an *internal marketing plan*, for implementing a methodology some of the steps in Jobber's and Fahy's suggested planning process, see Figure 3 below, are of less interest; business mission, core strategy and competitive advantage (all marked in italics), as these are part of the framework in which this concept shall be implemented and are not to be studied here. Implementing Six Sigma and achieving better results and more satisfied customers will perhaps in the long run improve and change the business mission, core strategy and competitive advantage, but for planning the implementation of the Six Sigma concept in this study there is no need to review these areas.

Business mission

↓

Marketing audit (Where are we? Where are we heading?)

↓ (external audit = PEST)

external = macro environment, the market, competition

SWOT (Where are we? Where are we heading?)

(synthezising the audit results)

↓

Marketing objectives (Where would we like to go?)

↓

Core strategy

↓

Competitive advantage

↓

Marketing mix decisions (How do we get there?)

↓

Organisation and implementation (How do we get there?)

↓

Control (Are we on course?)

Figure 3. Marketing planning (Jobber, D. and Fahy J (2002) interpreted by Köpsén, C. 2007)

All activities in this marketing planning process constitutes parts of the first phase of implementation, the Planning phase (see Table 2), and results in the (implementation) marketing plan.

2.3 Implementation

The marketing strategy defines what should happen and why. The implementation focuses on actions; who is responsible for the different activities, how is it going to be carried out, when and where. It has been argued that a combination of appropriate/inappropriate strategy and good/poor implementation will lead to various business outcomes (Jobber, D. and Fahy J. 2002).

The probability for a successful performance is a combination of the chosen strategy and performed implementation as shown in Figure 4.

		Strategy	
		Appropriate	Inappropriate
Implementation	Good	Success	Roulette
	Bad	Trouble	Failure

Figure 4. Marketing strategy, implementation and performance (Jobber, D. and Fahy J. 2002)

Much of what will happen in the future and much of what we can do is conditioned by what history has imposed on us (Normann, R. 2001). So if we are a *good enough* company is that what we will stay? Is *good enough* an incurable disease (Collins, J. 2001)?
Implementing an improvement program will redesign the organisation and the future. According to Richard Normann this takes place in two steps; first designing the tool, this study including the recommendations for implementation, with existing knowledge and

technology. The second step is using this tool to explore the unknown, the future and create the unachieved. The creation of that tool is designing for designing (Normann, R. 2001).

2.3.1 Phases for implementation

Implementing Six Sigma and achieving sustainable change requires a set of sequential activities to be implemented. De Feo and Barnard (2004) *prescribe* a five phase process, see Table 2, for implementation. Also Sörqvist Lars (2004) defines five phases for implementing an improvement program. Their respective names of the phases differ slightly, but the main objective of each phase is the same. Also studying other authorities in the area there seems to be a total agreement on what is required when implementing an improvement program successfully. Searching for good examples defining these five phases being the best way of implementing change the strategy becomes more and more clear, but there are also examples of companies failing not going all the way by not performing the last two phases. For example, on the IBM official web page (www.ibm.com) their road map for change is described and it only includes the three first of the five defined phases and it ends with the implementation phase as shown in Table 2.

Phase	**Sörqvist L.**	**De Feo and Barnard**	**IBM**
1	Decide/Introduction	Decide	Inception
2	Try-out phase	Prepare	Try-out
3	Implementation	Launch	Implementation
4	Expansion	Expand	-
5	Integration	Sustain	-

Table 2. **Implementation phases (Sörqvist, L., Barnard W. W., De Feo J. A.)**

One of the strengths in Six Sigma is the use of the last two phases, Expansion and Integration (or Expand and Sustain).

Some of the Fortune 500 organisations abandoned their Six Sigma efforts to soon because they did not truly benefit from their change initiatives and cost reductions fast enough or sustained long enough, or they did not achieve the culture changes needed. And why is that? They did not understand the basic requirements needed to sustain their efforts.

De Feo and Barnard (2004) define six reasons why organisations do not sustain financial performance and improvement over the long term:

1) Winning; Trying hard to become the market leader, the profit leader, or low cost producer takes the eyes off improvement initiatives.
2) A change in leadership; a change of the executive managing a Six Sigma initiative may make the initiative stop or slow down.
3) The organisation gets tired; of the initiative and moves to something else.
4) Infrastructure; The company does not maintain an infrastructure to continuously train the work force over time.
5) A merger or acquisition occurs; forcing a Six Sigma initiative to stop.
6) Macroeconomics impacts the organisation and other initiatives are prioritized.

Organisations do not realize that change, and improvements, must occur as a normal process. The change (improvement) process must be planned for, managed, and improved to enable the organisation to remain competitive. An organisation must plan for change, not only react to the need of change.
An effective Six Sigma initiative requires organisation-wide breakthroughs to occur to sustain results over time (De Feo and Barnard 2004). A successfully implemented improvement program follows the five phases defined by De Feo and Barnard (2004) according to Figure 5.

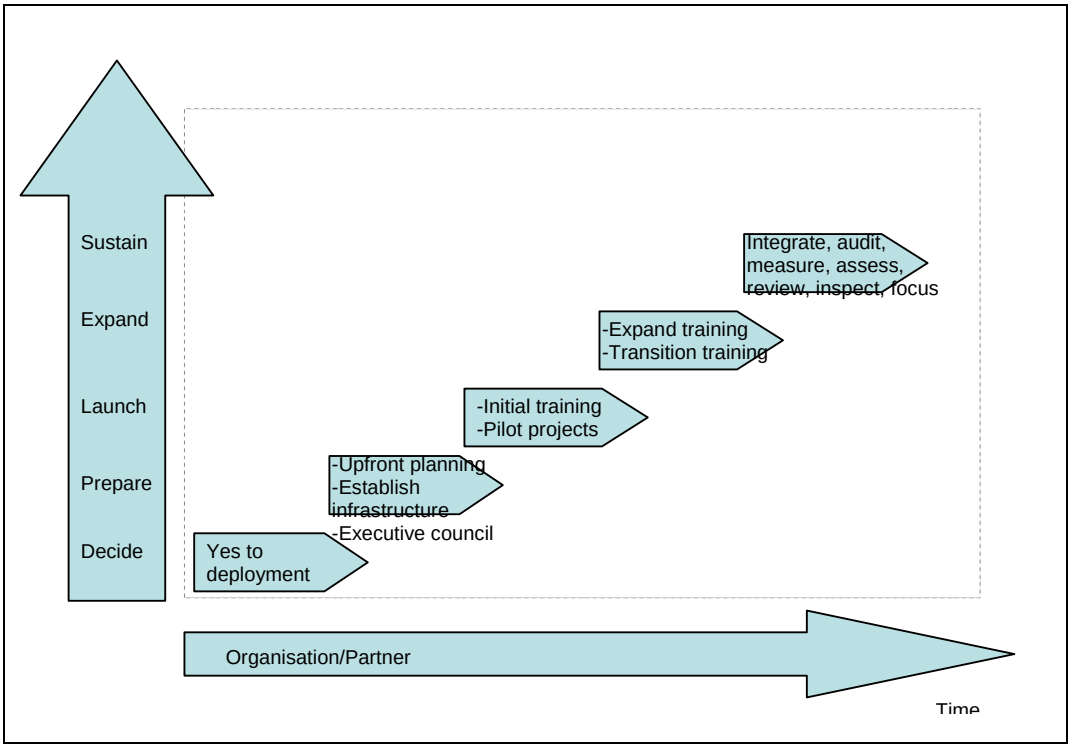

Figure 5. Five phases of implementing an improvement program (Barnard, W. W. De Feo, J. A. 2004).

The first phase (Decide), see Figure 5, starts with a decision that something has to be done. The phase ends with a plan for the change, which in this study will result in the recommendations for implementation. This study and the recommendations will contribute to top management insight about the need of an implemented improvement program and will in detail describe how this may be performed. The second phase (Prepare) requires planning and establishing an infrastructure for the improvement program. During the third phase (Launch) initial training is performed and one or several pilot projects are performed to spread and test the improvement and implement additional changes to the planned improvement. More training is performed during the forth phase (Expand) and this is also the phase for implementation of more projects; the improvement methodology is implemented throughout the organisation. The fifth and final phase (Sustain) is crucial for a successful implementation of an improvement program. During this phase the improvement

is measured, assessed and, further integrated to become a natural part of the business, and processes are put in place to make sure that the improvement sustains.

According to Richard Normann planning for reframing an organisation requires 5 steps during the first - Decide/Introduction - phase (see Table 2 for the different phases);

1. What are we?

   This first step aims at understanding the current situation; what assets the organisation has to start with. De Feo and Barnard (2004) prescribe assessing the organisation and identify the strategies and the goals. This is what e.g. Jobber and Fahy suggests as the marketing audit in the marketing planning process from Figure 3, defined later in this study.

2. Up-framing of business systems

   Up-framing means redefining the boundaries of the system the organisation is in at the moment, like oil companies calling themselves energy companies and for Coca-Cola in particular going from being a producer of sweetened flavoured water to being the manager of a brand. For Saab Avitronics this up-framing could be going from a culture of correcting errors and constant putting out fires to implementing a culture of continuous improvements. De Feo and Barnard are not as broad in their definition and "simply" talks about determining how this transformation may be integrated with existing methodologies already in the organisation.

3. Travelling in conceptual time

   Given the pretended and already reframed business that the organisation has a culture of continuous improvements and a well implemented methodology, define which the key driving forces to get there were.

4. Creating strategies scenarios

   During this step various possible and desirable scenarios are created and studied.

5. Translate the vision into a plan.

When all the work during step 1-4 above has been concluded it is all documented in a plan.

Interpreting Sörqvist, De Feo, and Barnard gives that in the second – Prepare - phase, see Table 2, improvement projects, pilot projects are implemented in a limited area with the purpose to learn, develop and adapt the improvement program to the organisation. The successful outcome of these projects shall be spread in the organisation and create the desire to perform more. During this phase the major and extensive training is performed. If it is possible this phase should be rather short and intensified creating the feeling that this is highly prioritized by the top management. The improvement program should also be visualized wherever possible; in meetings, internal news letters and on the internal web.
The program has to be adapted to the culture and current situation of the company.
Performing an internal audit will give what cultural factors that have to be considered.

The Implementation phase (see Table 2), the third phase, must be meticulously planned;

- all activities shall be prepared
- all roles shall be appointed
- the appointed individuals must be made available
- additional training must be performed
- project must be chosen and initiated

In this phase there are three alternative implementation strategies (Sörqvist, L. 2004);

- Total implementation

  "The American way", which includes kick-offs, massive propaganda, greater amount of training and a really active management team supporting the program. Total implementation is risky and you only get one chance; if it fails it fails.
- Partial implementation

  The border between the try out phase and implementation phase is vague and becomes natural during a partial implementation. It is harder to get attention and support implementing the program this way. It is also common that individuals involved are expected to participate in these projects additional to their regular work. If the implementation is performed during a longer period there is also a risk that the organisation falls back into previous habits.

- An existing program is extended
  A great advantage of extending an existing program is the use of existing structures. Not everything has to be invented and you can focus on the fewer new elements. But not everyone has any program at all implemented.

During the Expansion phase (see Table 2), the forth phase, the improvement activities are widened (Sörqvist, L. 2004). The first phases of performing improvement projects are usually focusing on internal problems and the main performing processes. This is now increased to also include support processes, focusing on customer satisfaction and also the suppliers.

The last phase, the Integration phase, is the naturalization phase, making improvement work a natural part of the organisation and the daily work.

2.3.2 Success factors at implementation

Success factors for implementation have been defined by various authors. Listing these factors in Table 3 gives the opportunity to see similarities of the opinions between some of these authors.

Success factor	**Sörqvist L. (2004)**	**Goldstein M.D. (2001)**	**Henderson K.M. and Evans J.R. (2000)**	**Schön K. (2006)**	**CPI Centre (2006)**
Commitment from Leadership	x	x	x	x	x
Clear and measurable goals	x			x	x
Clearly defined roles and responsibilities					x
Well designed execution and improvement plan					x
Training	x	x	x	x	
Link to customer, HR, and suppliers	x		x		

Success factor	Sörqvist L. (2004)	Goldstein M.D. (2001)	Henderson K.M. and Evans J.R. (2000)	Schön K. (2006)	CPI Centre (2006)
Organisation			x		
Communication to employees		x	x		
Methods for problem identification and selection of projects	x	x		x	
Understanding of Six Sigma methodology, tools, and techniques			x	x	
Resources	x	x			
Terminology	x				
Strategy for implementation	x	x		x	
Linking Six Sigma to strategy	x			x	
Focus on results	x			x	
Follow up	x				
Communication of success stories	x				

Table 3. Success factors for implementation of Six Sigma.

The factors above in Table 3 all have something in common; People. Regardless of what factor it all ends up with People. And, as S. Crom stated in his article (2005), 'After all, how can one separate the behaviour of processes from the behaviour of people? That must remain a central thought for those implementing Six Sigma.' Also Trompenaars F. & Hampden-Turner C. (1997) noted that there are always cultural differences among companies in the same country.

People and culture are closely connected and it is crucial to analyse the cultural aspects. K. Schön (2006) who studied implementation of Six Sigma in three companies in Sweden gives one statement from Åke Rosén at Volvo that 'Finding suitable people for Black Belt training remains the most difficult task'. Once again, one of the success factors, Training, ends up in People. 'Managing in a global environment means you manage people who are separated not only by time and distance, but also by cultural, social and language

differences. The main challenge is to integrate and coordinate these individuals in ways that will ensure success' (Forsström, H. 2006).
The major barrier for an effective implementation is the company's own employees, also according to authorities in the area like Jobber, D. and Fahy J. (2002).
Planning for opposition to change is an important part of the implementation plan. The pace of the implementation of the change is critical. A quick implementation threatens the culture and the politics of the organisation, whereas a slower implementation lets the employees gradually *move into* the new culture.

Besides planning for all of the most important elements of Six Sigma from Table 3 the following factors are also to be considered when giving recommendations for implementation, according to Sörqvist L.(2004):

- Aspects on the culture of the organisation
- Vision and objectives of the implementation, defined connections to the company objective, and an implementation strategy
- A communication plan including arguments and facts about the improvement program
- Techniques for measuring and follow up
- Risk analysis
- Mapping of problems in the organisation showing the potential in an improvement program,
- Previous attempts to implement improvement programs
- SWOT
- Owner of the improvement process, preferably the top management
- Top management support
- Role structure/Organisation
- Work descriptions for each role
- Training plan
- Resources trained in Six Sigma methodology, tool, and techniques
- Resource allocation
- Methods for problem identification and selection of projects
- Process for an improvement project

- Defined problem solving models
- Criteria for measuring success
- Defining driving forces, e.g. reward models
- Internal marketing
- Lessons learnt
- External support
- Carefully chosen projects
- Adapted model to the organisation, including the terminology

2.4 Conclusions from theory

Continuous improvement is an ongoing effort to improve products, services or processes. Continuous improvement is a prerequisite for survival and success, but has also become a requirement imposed on companies within the aviation industry.

Different improvement concepts, even a Six Sigma concept, have been introduced in companies during the years, but often failed. The companies have made it half ways and then stumbled. The reason for failing may have been mistakes made in the implementation plan or even the lack of an implementation plan. Crucial elements of the plan might have been missing. Maybe some of the critical success factors discussed in part 2.3.2. were not considered. In some cases also the important phases after the Implementation phase, the Expand and Integrate phases (see Table 2), were forgotten. To successfully implement a Six Sigma concept Saab Avitronics has to consider all of these elements. The success factors defined by Goldstein M.D. (2001) are, as also stated by Goldstein, likely to be relevant to the successful implementation of any major business initiative, and so also for Six Sigma.

The marketing environment composed by the forces and actors that affect the company has to be analyzed. But regarding the internal implementation of the Six Sigma concept the major and decisive affect is what the macro environmental factors taken together have created on the market arena; the need for improvement on all areas, the need to improve faster, and the need for a structured methodology to accomplish this. Saab Avitronics has to respond to this.

Research shows that implementation of Six Sigma in the aerospace industry is widely spread, see part 4.1.1. Michael Marx also stated in April 2006 that the Aerospace and Defence sector of the Fortune 500 are all using Six Sigma. And studying the customers, competitors, and potential partners of Saab Avitronics, Six Sigma is seen implemented to various extents everywhere, see Table 4.
Besides competing with the company's products it is an important competitive advantage being prepared to cooperate, being prepared to improve the company, and helping the customers to improve. And this means being prepared to support also in Six Sigma initiatives.

Six Sigma is a well proven improvement concept which is here to stay. Just as obvious is that the aviation industry in general has adapted the concept of Six Sigma and that Saab Avitronics needs to do the same. Factors for successful implementation have been compiled and also elements for successful planning of this implementation. Crom S. (2000), Gowen C.R. (2002), and Schön K. (2006) all state what can also be concluded in the theory part of this study; that Six Sigma needs to be implemented differently in various parts of the world. For one it is required that this implementation considers the different standards, regulations, and customer requirements Saab Avitronics has to adhere to.
It will all be put together in the coming chapters of this study.

3 Methodology

This methodology chapter presents the research methodology in general in part 3.1. Part 3.2 describes the methodology for the performed survey and part 3.3 the validity and reliability of the survey.

3.1 Research methodology

The research methods for this study include both theoretical and empirical methods. Both groups of methods contribute to the strategy and action plan for implementation of Six Sigma.

The literature studies and also the sources found on the Internet form the basis for how Six Sigma, in theory, is implemented the most successful way. Theoretical standpoints and empirically proven successes from the pioneers in the area and the most recognized men and women in the field are analyzed.

The methodology for the empirical part consists of

- a marketing audit to identify the reality in which Saab Avitronics acts and the reality, in which the Six Sigma concept is to be implemented
- a SWOT analysis to identify strengths, weaknesses, opportunities and threats to define the prerequisites for successful implementation of Six Sigma at Saab Avitronics, and,
- an internal survey to measure *management temperature*.

A marketing audit is performed to find the factors that would affect the implementation of Six Sigma and a SWOT analysis to find the company's ability to react on this reality and also the ability to proactively act for a successful implementation. To find management readiness to implement the concept I chose also to perform the survey.

A more elaborated methodology part is also included in the part discussing the internal survey, see part 3.2.

3.2 Survey Methodology

When the survey was to be conducted my plan was to implement the improvement concept on Saab Avitronics site in Jönköping only and after being exercised there the success stories themselves would create suitable conditions to implement the concept on the other Product Areas as well. The main interest was therefore to understand the *status* of those who would influence the implementation the most; the management team and the quality department, and perform the survey on those. The survey was also performed on the group of quality managers on all product areas in Saab Avitronics as this group is vital for the implementation. The (other) employees in Development, Production, and the supporting functions were not considered critical for this part of the research.

For the study and for planning the implementation the following areas were of interest:
- the need of an improvement process (in general)
- the knowledge of statistics and the need of using statistics
- the knowledge of and the attitudes towards Six Sigma.

Even if the population was limited and it would even be possible to perform a qualitative survey on all the respondents, a questionnaire was chosen, see Appendix A. Also, more qualitative discussions would be held anyway in the organisation in general, in the group of quality managers in particular, and also during the BIP project.

To aid the analysis and also to create descriptive pictures for presentation the software tool for statistical process control, Minitab, was used.

The questionnaire was designed as a number of statements. To each of the twenty (20) statements the respondent gave an answer to what extent, on a scale 1-10, he agreed on the statement. This Likert scale shows the amount of agreement or disagreement. There was also the possibility to give the answer ‘I don’t know’ to reduce the risk of any uncertain respondent giving a neutral answer in the middle of the scale.

There are two main objectives in designing a questionnaire:

- To maximize the proportion of subjects answering the questionnaire - that is, the response rate. As the questionnaires were to be handed out at meetings and collected immediately this would not create a problem and a high response rate was expected.
- To obtain accurate relevant information for the survey.

The target group was in all 34 persons. The group is small but representative as it consists of the management team and the quality department; those who will influence the implementation of Six Sigma the most. Though, there was no loss of response at all and so the response rate was 100%.

3.3 Validity and reliability of the survey

I want to generalize the result of the survey (and the target group of the survey) to a greater population; to the whole management team and Quality organisation of Saab Avitronics. The survey was a 'group survey' (Sörqvist, L. 2000) and was distributed to the respondents at internal training sessions. This is a quick and cheap way and the risk of response loss is small. The performed survey should be representative for the whole of Saab Avitronics, even though performed on only parts of the organisation.

The validity of the survey is the ability to measure what was supposed to be measured. The result is found valid and useful for planning the implementation. Contrary to survey results where the result are grouped in segments and mean values are studied, the main interest of this survey outcome was to find the lowest and worse results, because that is where the main efforts during implementation would be put. As it will not be possible to act on individual single low results, e.g. a low competence level or a hostile attitude towards the concept some of the implementation activities would need to be planned as if the whole target population had this result.

A questionnaire will always produce numerical results, even if they are meaningless. Only a test of reliability can tell if the results are trustworthy and can be used as basis for business decisions. A reliable questionnaire is one that would give the same results the next time it is performed. The reliability of the survey is found high and is expected to give the same result if performed again.

An effect from the group survey was the affect I, by simply talking about Six Sigma and the need for an internal improvement process, might have had on the results. The respondent may want to agree with what I (the quality manager) say. The respondents could have been affected also by each other, giving the response in a full meeting. There may also have been a pressure to conclude the survey quicker than the time necessary to answer the questions thoroughly. In total the possible negative effects are to minor to take into consideration.

Considering that the total number of employees in Jönköping is 240 and the survey way performed on 24 of these gives the response rate of 10%. In total the survey response rate was 34 out of 1200, which gives about 3%. The survey was performed on employees with higher education and it is likely that the competence level, regarding the survey questions, of the other employees are the same or lower. Regarding the attitude the same conclusions cannot be taken, but the attitude (problem) towards the concept is only critical for the success of the implementation if it exists in the management team.

4 Empirical data

The empirical data includes a marketing audit in part 4.1 mainly focused on the micro environment, a discussion on the *special conditions* of Saab Avitronics in part 4.2, a SWOT of Saab Avitronics in part 4.3, and finally in part 4.4 the results of the internal survey.

4.1 Marketing audit

A marketing audit is a comprehensive, systematic, independent, and periodic examination of a company's or business unit's marketing environment, objectives, strategies, and activities with a view to determining problem areas and opportunities and recommending a plan of action to improve the company's marketing performance (Kotler, P. and Keller, K. L. 2006).

The marketing environment is composed by the forces and actors that affect the company. These factors are usually classified in micro environmental and macro environmental factors see Figure 6. A major purpose of environmental scanning is to discern new opportunities (Kotler, P. and Keller, K. L. 2006).

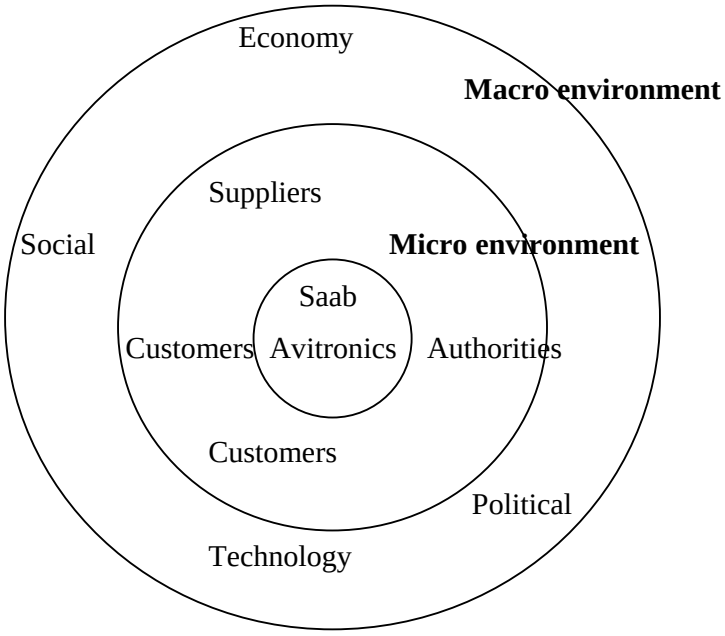

Figure 6. Micro- and macro environmental factors of Saab Avitronics.

The macro environmental factors profoundly affect Saab Avitronics and the business. But regarding the implementation of the Six Sigma concept the major and decisive affect is what these macro environmental factors taken together have created on the market arena; the need for improvement on all areas, the need to improve faster, and the need for a structured methodology to accomplish this. A successful company recognizes and responds to this need.

The micro environmental environment consists of Customers, Competitors, Suppliers and Authorities. Besides directly and indirectly affecting each other in the micro environment they all are affected in a common macro environment. Having recognized the need in the macro environment it becomes crucial to find out the status in the micro environment.

No further mapping of the macro environment is performed in this study, besides the statement about the need of a Six Sigma implementation, also as this work comes from the assumption that there is a need and consequently a need for implementation.

4.1.1 Micro environment

The objective of this micro environmental audit is to find the extent of Six Sigma implementation in the aviation industry; which ones of the customers and competitors have already implemented Six Sigma and may Six Sigma come as a requirement from the customers in the future?

It is crucial to study the market micro environment; the customers, competitors and potential partners and their Six Sigma initiatives or lack of initiatives to:

- see the trends in the aviation industry
- if the customers, competitors and potential partners of Saab Avitronics are ahead of the organisation their need for cooperation in their Six Sigma can soon be expected (as supplier or partner)
- maybe predict a requirement to have Six Sigma (or a similar methodology) implemented
- create confidence that implementing Six Sigma is the right thing to do
- find suitable benchmarking partners
- speak the same language as customers and competitors.

It is now about twenty years ago since Motorola introduced Six Sigma as a methodology to improve processes. Six Sigma is still alive and benefiting companies all over the world. Michael Marx states in April 2006 that, not surprisingly, the Aerospace and Defense sector of the Fortune 500 are all using Six Sigma; Boeing, General Dynamics, Goodrich, Honeywell International, L-3 Communications, Lockhead Martin, Northrup Grumman, Raytheon, Textron, and United Technologies.

In iSixSigma Magazine's Jan-Feb 2007 issue Michael Marx, iSixSigma research manager, points out that the Fortune 500 companies have over the past 20 years saved an estimated $427 billion. The estimate is based on reported savings linked to Six Sigma in public documents. He also adds, "About 53 percent of Fortune 500 companies are currently using Six Sigma -- and that figure rises to 82 percent when you look at just the Fortune 100."

Searching the Internet for companies in the aviation industry that to some extent have implemented Six Sigma and published information on this and comparing those to the main customers, competitors and potential partners of Saab Avitronics gives Table 4 below.

Airbus (Germany)	EADS	Liebherr
Augusta	FMV	Moog
Boeing	GE	Rockwell Collins
BAE Systems	Goodrich	Sikorsky Aircraft Corporation
Diehl Aerospace	Honeywell	

Table 4. Main customers, competitors, and potential partners that to some extent have implemented Six Sigma.

4.2 Special conditions

In this part the special conditions, the controlling processes implemented and forced upon Saab Avitronics are discussed, and the possible limitations this may imply when implementing Six Sigma. Possible limitations are here not internal limitations such as organisational structures, culture or competence, but the external ones; laws, rules and customer requirements that apply to the organisation and which have to be adhered to. It is discussed if these conditions can coexist in a Six Sigma culture and also how the reporting and approval processes of Saab Avitronics look like. Is it possible to constantly improve and change internal processes, which is really beneficial and worth the effort, and at the same time have the same processes rigidly documented, tested, proven effective, quality approved and in some cases also audited and/or qualified by customers and authorities?

The laws, rules and standards that Saab Avitronics have to adhere to and which have an effect on its processes and products are;

- ISO 9001:2000
- EN9100:2003
- ISO 14000 and the environmental laws
- Part 21
- Part 145
- Nadcap

but also

- customer approved processes
- customer approved product material or design
- GRESS standard (customer specific)

Products with an intended use in a flying environment are approved and certified by the customer when development, verification and validation have been finalized. The conformity (i.e. the approval and certification) process is strict and nothing may deviate from plans and processes, expected results and customer requirements. Once conformed, a product (to be produced) may not be changed in any way; not in material and not in the

processes in which it is produced. If anything has to be changed, the product has to be re-conformed, a process both time consuming and expensive.

For all the laws and rules the company have to adhere to, I will find and define:
What is this particular law or rule?
Why does it exist/What does it do?
How are reviews/audits performed?
How is the approval or certificate issued?
Can Six Sigma coexist with this law, rule or standard in theory?
If the management system changes and/or something with regard to this approval/certification, how is this approved and included in the approval?

4.2.1 ISO 9001:2000, EN9100:2003 and ISO 14000

The ISO 9000 series emerged in 1987 and represented the consolidated views and directions for the future of trading between countries (www.sis.se). ISO 9001:2000 specifies requirements for a quality management system that can be used for internal application by organisations and for certification. It focuses on the effectiveness of the quality management system in meeting customer requirements.
A company that implements a management system according to ISO 9001 gives confidence to the surrounding world that the company has a basic quality level. If this management system is also reviewed by external auditors and certified this quality level is verified and does not have to be checked by the customer himself.
'ISO 9000 has a very strong role to play in the achievement of Total Quality for any business – but it cannot achieve the goal by itself in even the best and most well planned implementation' (Tilley, B. 1996).
Brian Tilley also states that the ISO 9000 series, and so ISO 9001, must be seen as an integral part of strategic business development – not an answer to all things by itself, but an essential part of the answer. What he states is that with ISO 9001 alone you will not do well enough. Other tools and methods are needed too.
Once every year Saab Avitronics is audited by auditors from an accredited bureau. The certificate, which was received for the first time in 1993, is renewed if all requirements are fulfilled and there are no major findings which prevent this.

EN 9100 is based on ISO 9001. EN 9100 adds the additional requirements necessary to address both civil and military aviation and aerospace needs. EN9100 provides additional requirements to all but element 4.7, Control of Customer Supplied Product, of the twenty elements of ISO 9001.
Det Norske Veritas also audits the organisation against EN 9100:2003 and at the same time as the ISO 9001:2000 audits. The certificate for both of these standards is the same, which means Saab Avitronics has to comply with both standards to be certified. Saab Avitronics first received the EN 9100 certificate in 2004.

ISO 14000 is a series of standards covering a number of environmental topics. ISO 14001 lays down a model for an environmental management system that can be adopted by any organisation and can be certified by an accredited certifying body, just like ISO 9001 and EN 9100 above.
Working with the ISO 14000 and thus creating a system for environmental issues give the structure for effective and efficient environmental work. The environmental management system is a voluntary tool simplifying the work and the standards provide a tool for continuous improvements.
ISO 14000 itself or the agreement with the certification body does not require any additional processes if Six Sigma is implemented.
Saab Avitronics has implemented ISO 14000, but has not yet decided to certify the system. If and when this is performed the same notification obligation as with ISO 9001 and EN 9100 will apply.

4.2.2 Aviation authorities

For products designed, produced or maintained for civil aviation, Saab Avitronics are under the surveillance of aviation authorities. A product needs a design approval, production approval or maintenance approval for the organisation to be allowed and able to deliver a product with the right certificates within these areas. Having a production approval, a Part 21 POA (Production Organisation Approval) e.g. means that the internal procedures for production and organisation are audited and approved by the authorities. Some changes to these approved procedures are mandatory to inform the authorities about and may need a new approval from the authorities. Saab Avitronics cooperate with Luftfartsstyrelsen for

the European market and Federal Aviation Authorities for the American market. The European Aviation Safety Agency (EASA) is the centrepiece of the European Union's strategy for aviation safety. 'Our mission is to promote the highest common standards of safety and environmental protection in civil aviation' (www.easa.eu.int/home).

Luftfartsstyrelsen is the Swedish aviation authority. Luftfartsstyrelsen design rules and regulations perform audits and issue approvals. Luftfartsstyrelsen also supervise the civil aviation in Sweden.

Saab Avitronics has a production approval since 2001 and plan to be approved for maintenance during 2008.

Every six months the Production Organisation Exposition is audited and this will also apply to the Maintenance Organisation Exposition, once it is approved.

The notification obligation is stricter for Part 21 and Part 145 than with the ISO standards and the notification requirement is also an actual part of the standard.

'Each change to the terms of approval shall be approved by the Competent Authority. An application for change to the terms of approval shall be made in a form and manner established by the Competent Authority. The applicant shall comply with the applicable requirements of this Subpart.' (Part 21 §21A.153)

The notification, and also the approval of the change, has to be performed before the change is implemented in the management system and taken into operation/use.

4.2.3 GRESS

General Requirements for Equipment and System Suppliers, GRESS, is a standard developed by Airbus. The GRESS comprises activities and documents; activities that need to be performed and documents that are required to be delivered by the supplier during design, and while manufacturing or delivering products. This standard is agreed upon between the customer Airbus and Saab Avitronics. Adherence to the standard is audited at several occasions during a project. For deviations from the standard corrective actions are required within a stipulated time period. The standard and the customer interpretation of the standard also oblige Saab Avitronics to;

- constantly improve the processes to reach *zero fault*
- use of statistical methods

The Six Sigma concept corresponds to the GRESS requirements. The GRESS supports Six Sigma and does not require special treatment or notification, that is within the scope of the standard or if it does not affect the on-going customer project.

4.2.4 Customer and authority approved design and production documentation

Customer agreements and contracts bring special requirements of different kinds. Depending on the extent of the contract the organisation is affected on different levels. Most often an organisation within this industry is required to fulfil the requirements of standards like ISO 9001 and EN 9100. Besides that additional requirements may need to be fulfilled. If some of these requirements are changed during the period of the contract it needs to be approved by the customer before implementation. The requirements can be grouped info different categories depending on the area they affect:

- product design; every change has to be approved
- processes; have to be approved by the customer if they are changed during which they are used, e.g. development processes during the development phases
- organisation
- premises

Some products for the civil aviation industry are developed and produced by Saab Avitronics in projects using customer and authority approved processes documented in project plans and with approved results documented in different quality documents. Once approved these processes cannot be changed without the process of having a renewed approval by the customer. Even if calculations in a Six Sigma project show that most beneficial improvements could be made this would probably not even be a possibility to be considered once a process (and product) has been approved.

4.2.5 Nadcap

Nadcap is the leading, worldwide cooperative program of major companies designed to manage a cost effective consensus approach to special processes and products and provide continual improvement within the aerospace industry (www.pri.sae.org/Nadcap).

The aerospace industry has agreed that the Nadcap program has distinct advantages, such as improving product quality by focusing on overall supplier performance and reducing the number of audits required each year, which lessens the annual cost of auditing both to the supplier and to the prime.

Special Processes are those processes where the parameters are directly influenced by component geometry and/or the results cannot be confirmed by inspection. The Nadcap program includes the following special processes: Aerospace Quality Systems, Chemical Processing, Coatings, Composites, Distributors, Elastomer Seals, Electronics, Fluid Distribution Systems, Heat Treating, Materials Testing Laboratory, Non Destructive Testing, Non conventional Machining and Surface Enhancement, Sealants, and Welding.

Saab Avitronics may need to Nadcap certify some of the production processes. Having a process certified will mean that every change to that process will have to be approved by Nadcap. This is an extensive and expensive process.

Customer	**AQS**	**CP**	**CT**	**COMP**	**DIST**	**SEAL**	**ETG**	**FLU**	**HT**	**MTL**	**NDT**	**NMSE**	**SLT**	**WLD**
Boeing		X		X					X	X	X	X		X
Airbus		X		X			X		X	X	X			
EADS MTAD		X		X					X	X	X	X		X
Eurocopter		X	X	X					X		X			
Sikorsky Aircraft	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 5. Saab Avitronics customers and their Nadcap requirements. (Schön, P. 2006) *(Saab Avitronics applicable processes marked in light blue)*

Table 5 shows all the *special processes*, the ones at Saab Avitronics that are candidates for Nadcap certification and which ones of the customers that have Nadcap certification requirements on the processes.

Having *special processes* Nadcap certified is an improvement activity itself. And a thorough process like the Nadcap one would not require an additional review with Six Sigma methodology for a process that needs improvement. After a Nadcap certification, these processes will probably not be the object of interest for the level of improvement that Six Sigma implies. Nadcap certified special processes would therefore not hinder the implementation of Six Sigma.

4.3 SWOT

A SWOT analysis is a structured approach to evaluate an organisation's strengths, weaknesses, opportunities, and threats. It also provides a simple method of synthesizing the results of the marketing audit (Jobber, D. and Fahy, J. 2003). The method is also valuable before giving recommendations for implementation of Six Sigma as it is necessary to know where and why the organisation is now, before setting the objectives.
For this evaluation only Saab Avitronics' absolute strengths, weaknesses, opportunities, and threats are of interest. The relative ones, as compared to the competition, are not of interest as the recommendations for implementation are internal Saab Avitronics only.
Every factor has to be questioned as of its effect on implementing the concept of Six Sigma.

Working through the SWOT process, with implementation of Six Sigma in focus, will give a clearer idea of:

- what do Saab Avitronics do well now, and what are the strengths
- which are the internal weak spots
- opportunities
- threats in the external environment (threats are in this context interpreted more as risks during the implementation of Six Sigma)

The strengths, weaknesses, opportunities, and threats of Saab Avitronics implementing Six Sigma are as shown in Table 6.

Strength	**Weakness**
• Two trained Black Belts exist already • BIP process exists • Experienced project managers • Top management motivated to implement a process for improvements • One successful Six Sigma project already performed • A larger amount of money is budgeted for Improvement projects 2008	• Limited competence on statistics • Limited competence on Six Sigma methodology and tools • No improvement culture • No resources available for this program • Many other improvement initiatives ongoing • Lack of a driving force
Opportunity	**Threat**
• Impress customers by introducing Six Sigma methods and tools • Save money by performing Six Sigma projects • Customers require measurements, improvements and/or Six Sigma • Six Sigma is spread in the aviation industry which creates possibilities to share experiences and find benchmarking partners. • Good experience and contact with Sandholm Associates • A lot of improvement areas already identified. • Group-wide efficiency improvement program to cut costs, reduce tied-up capital and improve process efficiency.	• Six Sigma gets a bad reputation on the market • Cultural differences • Geography/Sites are spread around the world • Standards that require approval of internal processes. • Authorities that require approval of internal processes • Customer that require approval of internal processes. • increasing costs • customer projects requiring resources

Table 6. Saab Avitronics SWOT when planning implementation of Six Sigma.

It is especially worth notifying that Saab Avitronics already has an adapted and documented Business Improvement Process, see strengths in Table 6 above, which is suitable for it's business and current organisation. That is a good thing. Yet, it is not used.

Top management ordered a Business Improvement Process from the Quality Department in 2006. It was suggested and decided that the process should be based on Six Sigma principles, but adapted to the already implemented concept for project management, PROPS. BIP is now completed as far as the process is documented, reviewed and approved, but it is not yet released. Also no other activities have been performed to implement the concept.
Two management Six Sigma seminars have been proposed by Sandholm Associates to be performed in the near future, but no invitations have yet been seen.

Saab Avitronics, who *do not use* the Business Improvement Process, have no advantage over those who *does not have* an improvement process at all.

4.4 Internal survey

Companies undertake surveys to learn about people's knowledge, beliefs, preferences, and satisfaction, and to measure these magnitudes in the general population (Kotler, P. and Keller, K. L. 2006). The survey that was performed aimed at understanding the internal market; examining Saab Avitronics' view on its own knowledge in the area of Six Sigma, improvement methodology, statistics, and the attitudes towards implementing a methodology based on Six Sigma. The survey had also the purpose of creating interest and informing that something was about to happen. Finally the survey had the purpose of finding out if the knowledge of statistics was low and that the probable reluctance towards using statistics and statistical methods was in fact due to a competence gap rather than an attitude problem, which according to me would be easier to fix.
Analysis of the results from an internal survey gives an important input to the empirical research and helps analyze the situation at Saab Avitronics to find suitable recommendations for the implementation of Six Sigma.

A response giving grade 6 or more (on the scale of 1-10) is in this survey interpreted as a positive content. The positive content is what is most interesting, not necessarily to what extent the respondents' grade a statement 6, 7 or 8.
The results of the survey are presented in Figure 7 – Figure 22 below.

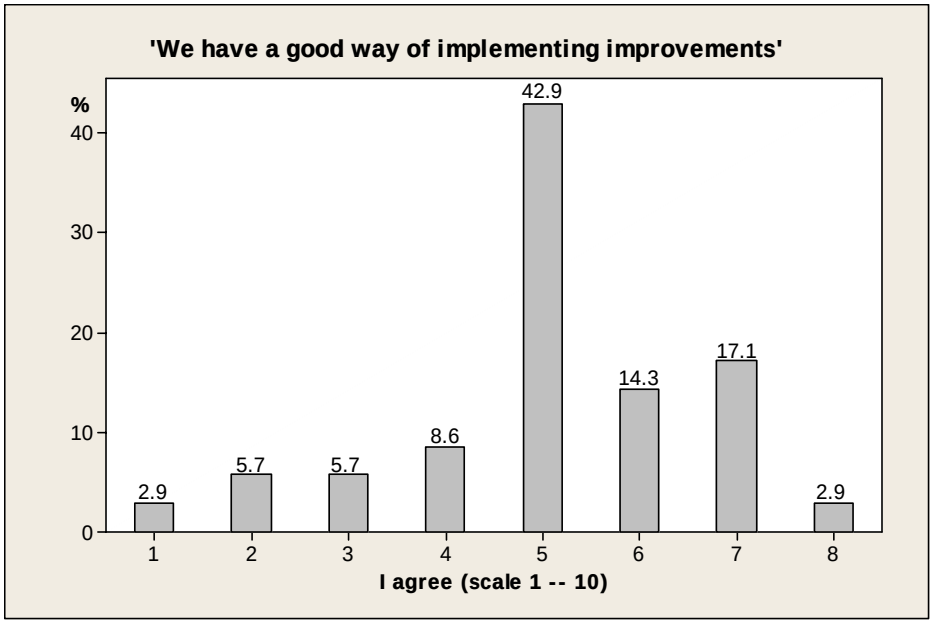

Figure 7. Result of survey statement 'We have a good way of implementing improvements'.

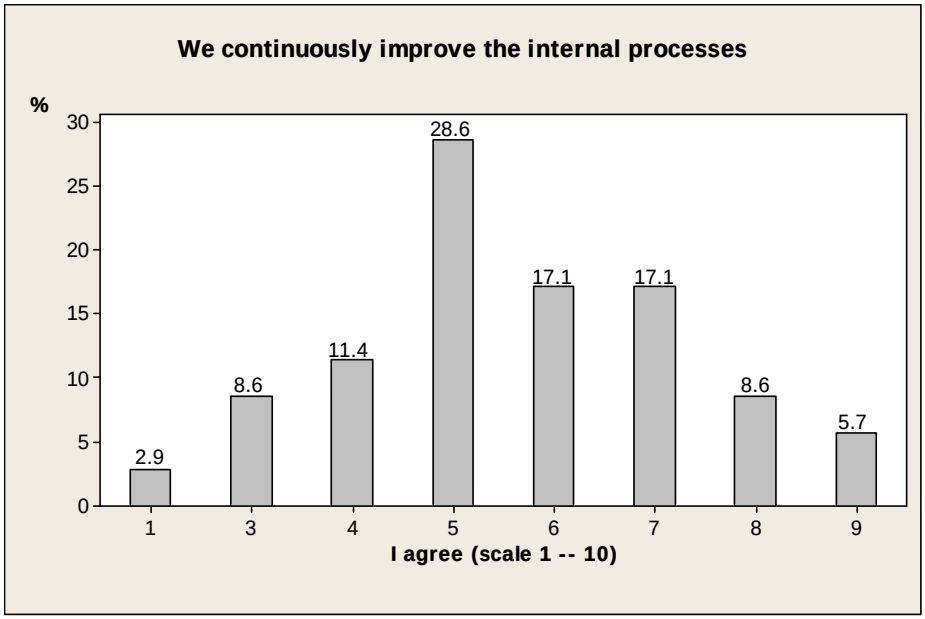

Figure 8. Result of survey statement 'We continuously improve the internal processes'.

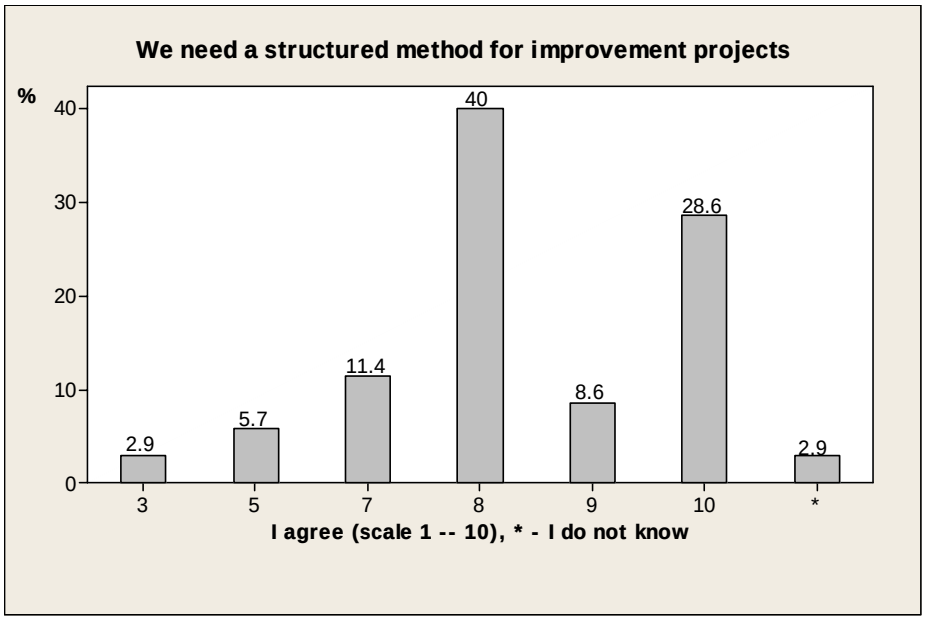

Figure 9. Result of survey statement 'We need a structured method for improvement projects'.

In Figure 8 it is show that nearly half (48.5%) of the respondents think (grade 6-9) that 'We continuously improve the internal processes' and Saab Avitronics do, or at least thinks it does. A less amount, 34.3%, of the respondents think that 'We have a good way of implementing improvements' (grade 6-8), see Figure 7.

A great majority of the respondents see Figure 9, consider that Saab Avitronics needs a structured method for improvement projects. 88.6% gave the response 7 or higher and 28.6% the highest response (grade 10); on requirement on a structured methodology – 'Saab Avitronics needs a structured methodology for improvements'.

These results support the concept idea and as it was primarily the management team responding this could be interpreted as 'management support' of the idea – one of the critical success factors defined in part 2.3.2.

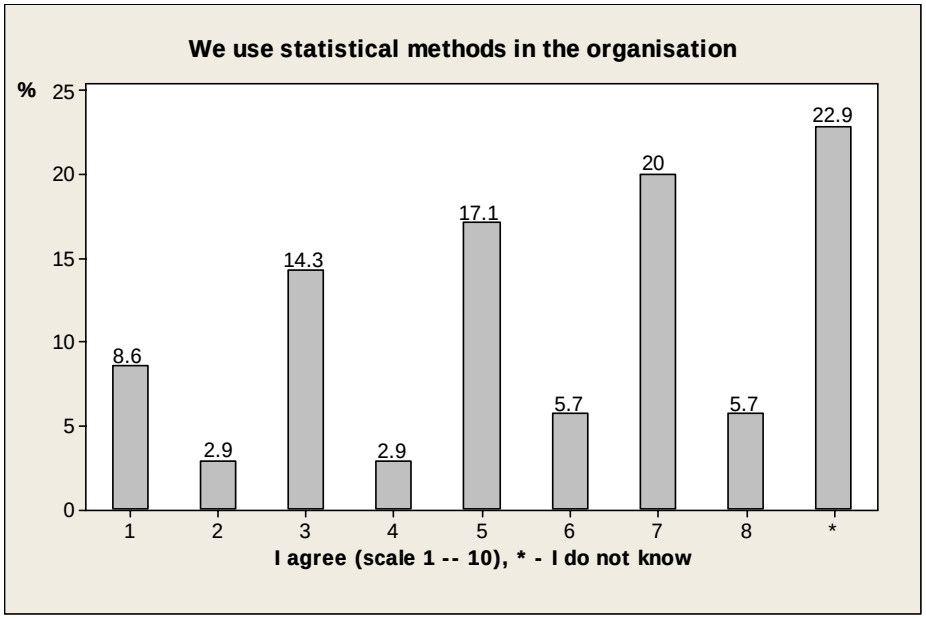

Figure 10. Result of survey statement 'We use statistical methods in the organisation'.

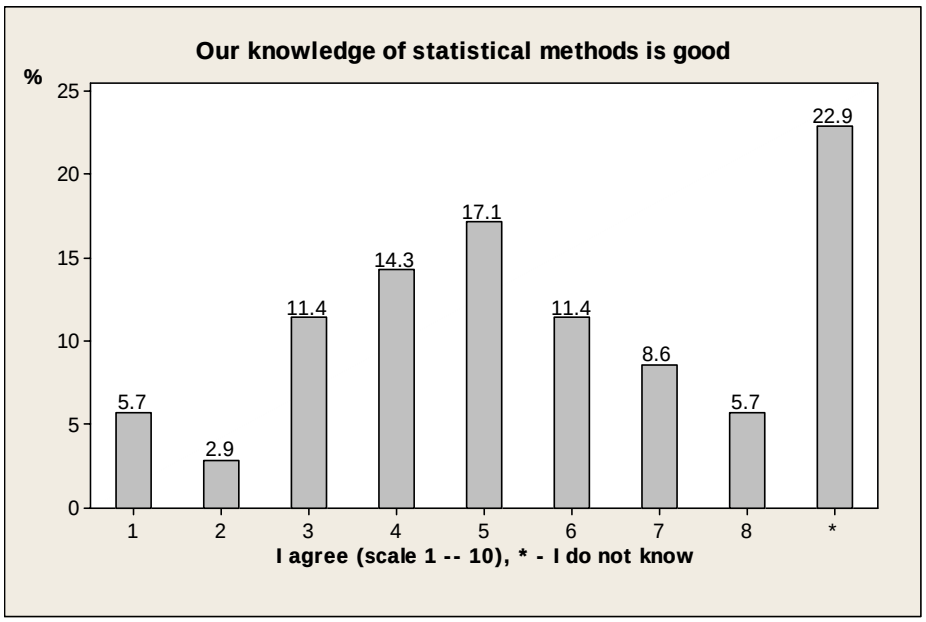

Figure 11. Result of survey statement 'Our knowledge of statistical methods is good'.

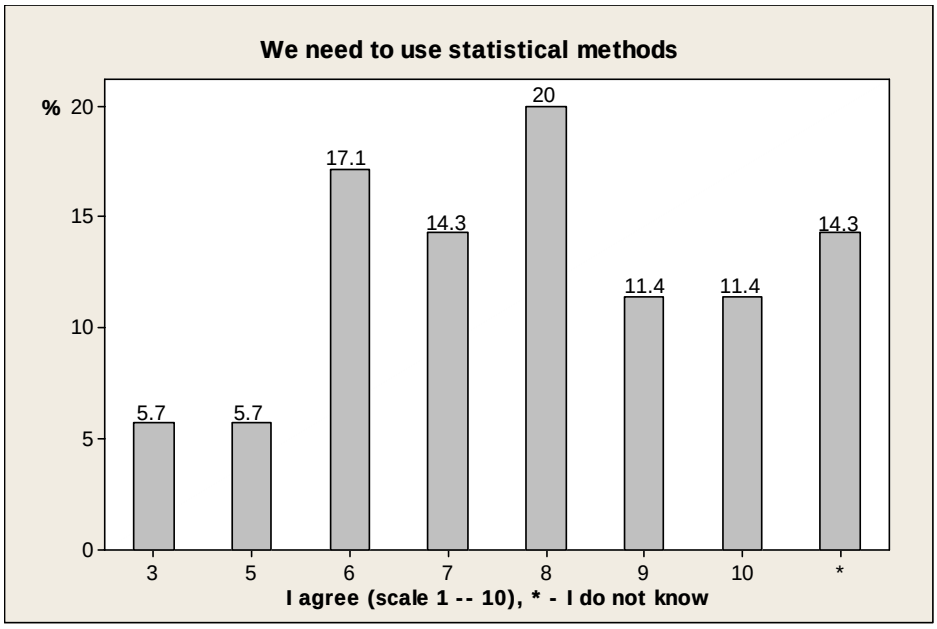

Figure 12. Result of survey statement 'We need to use statistical methods'.

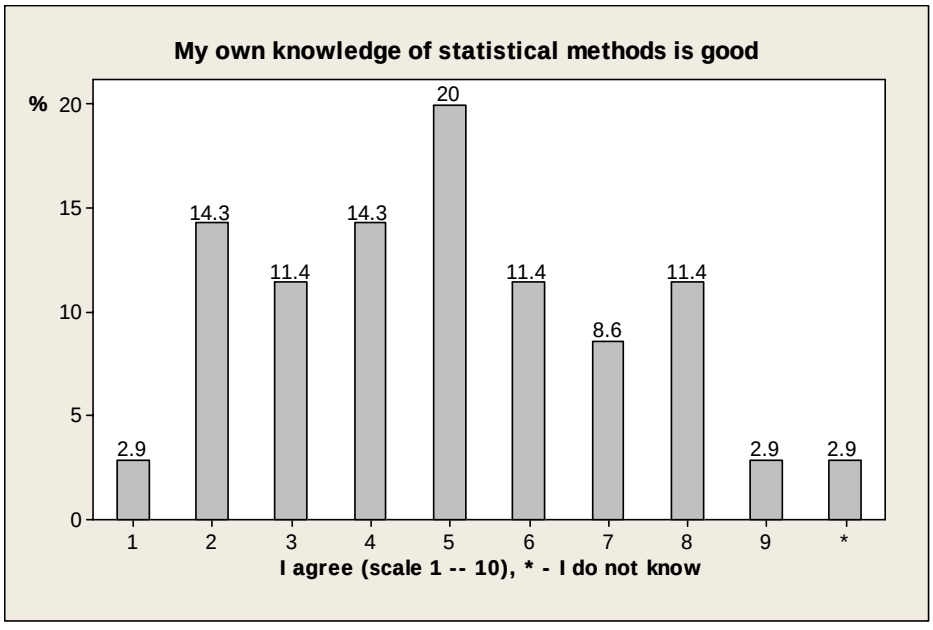

Figure 13. Result of survey statement 'My own knowledge of statistical methods is good'.

Figure 10 shows that 22.9% of the respondents do not know if Saab Avitronics use statistical methods and that just as many, see Figure 11, do not know the level of the statistical knowledge at all and only 25.7% think that the level of knowledge is satisfactory. This, for first, is interpreted as a low total competence level in statistics. Furthermore, only 31.4% (see Figure 10) consider that the company use statistics today and 25.7% that the knowledge of statistics is good (Figure 11). A predominantly part responds in Figure 12 that 'We need to use statistical methods' which supports the idea of Six Sigma.
There is a greater extent of respondents considering themselves having a good knowledge of Six Sigma, see Figure 13. It is promising that 34.3% think that they have good knowledge of statistics. This is really a hidden opportunity.

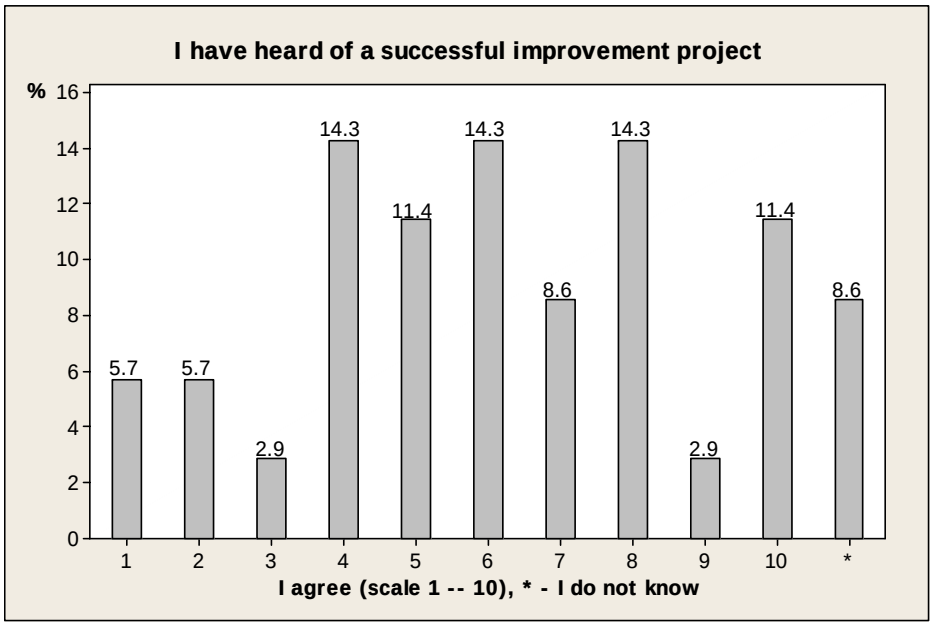

Figure 14. Result of survey statement 'I have heard of a successful improvement project'.

Only half of the respondents (Figure 14) gave grade 6 or higher to the statement 'I have heard of a successful improvement project'. This response really confirms the need for a methodology making this come true. I am surprised that 51.5% of the respondents answered 'I do not know' and I interpreted this as that they have not heard of any successful improvement projects.

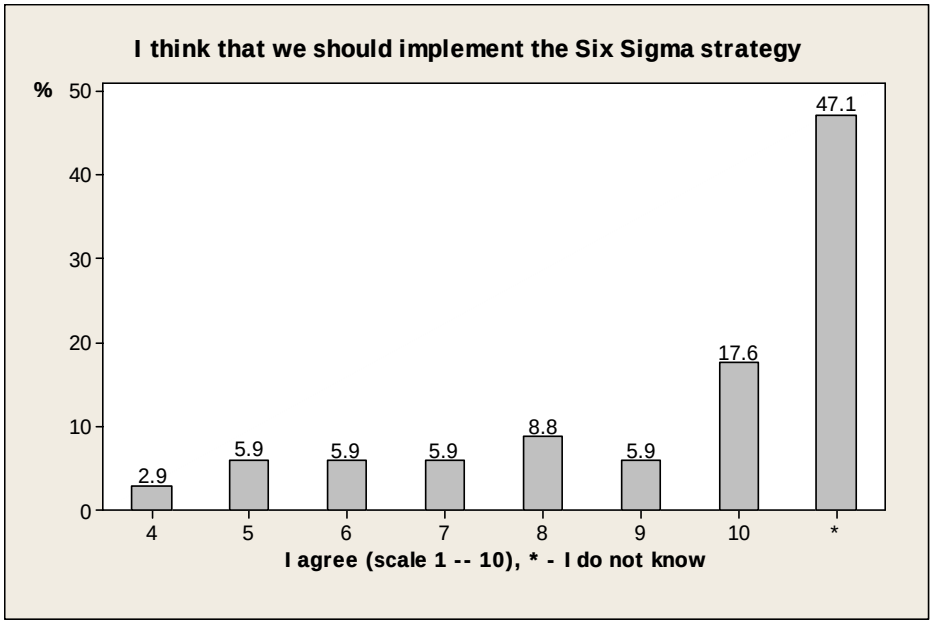

Figure 15. Result of survey statement 'I think that we should implement the Six Sigma strategy'.

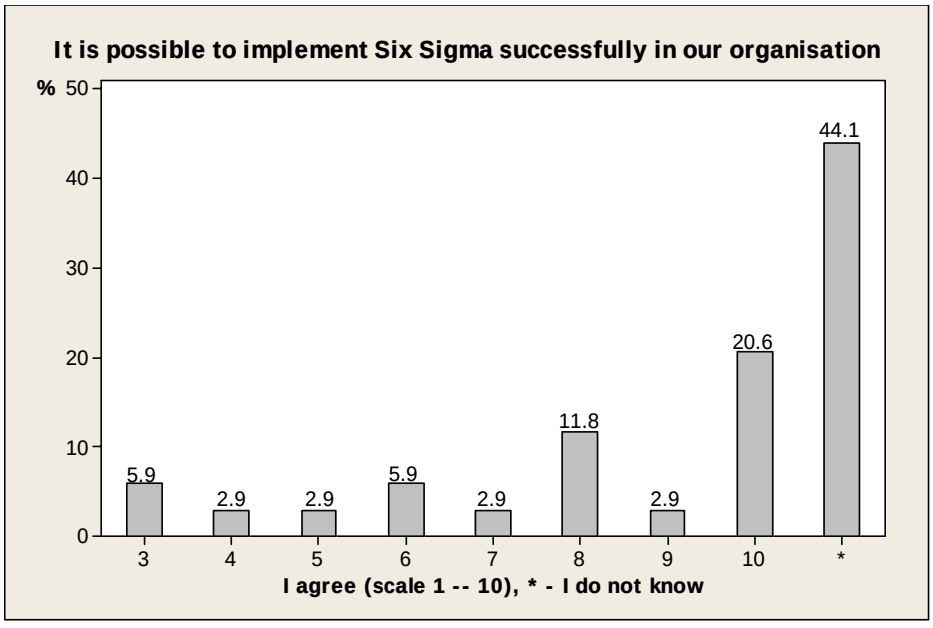

Figure 16. Result of survey statement 'It is possible to implement Six Sigma successfully in our organisation'.

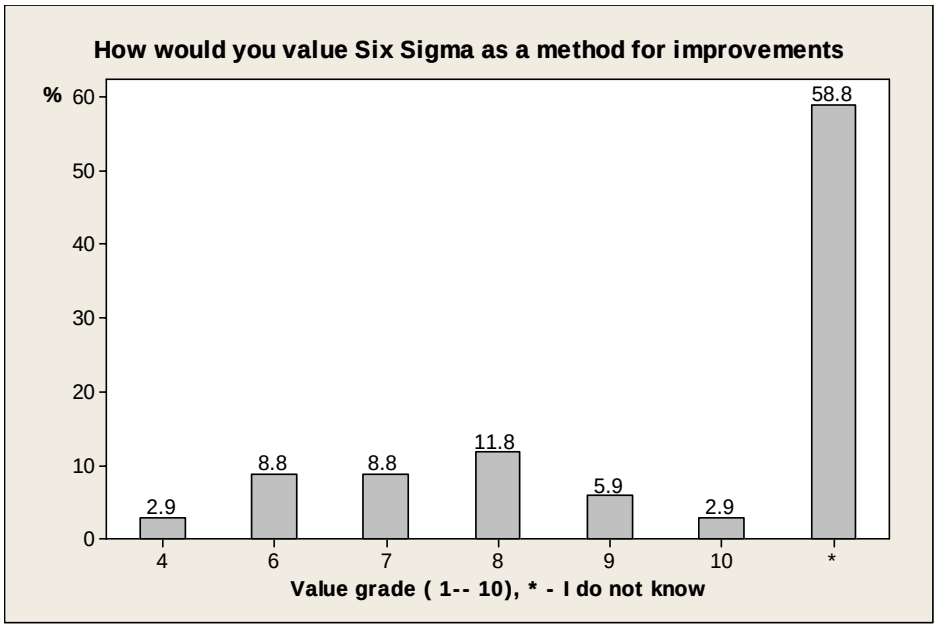

Figure 17. Result of survey statement 'How would you value Six Sigma as a method for improvements'.

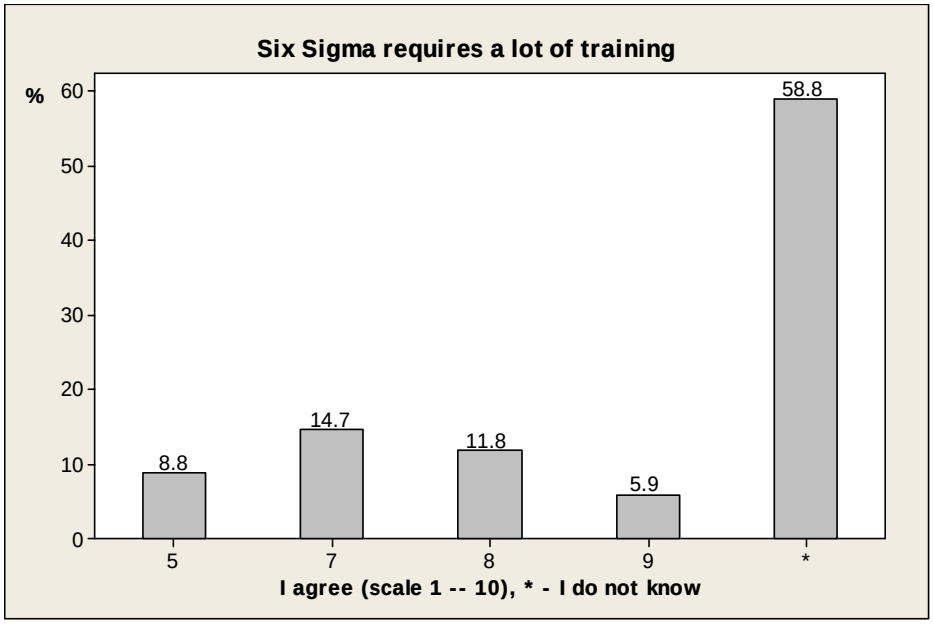

Figure 18. Result of survey statement 'Six Sigma requires a lot of training'.

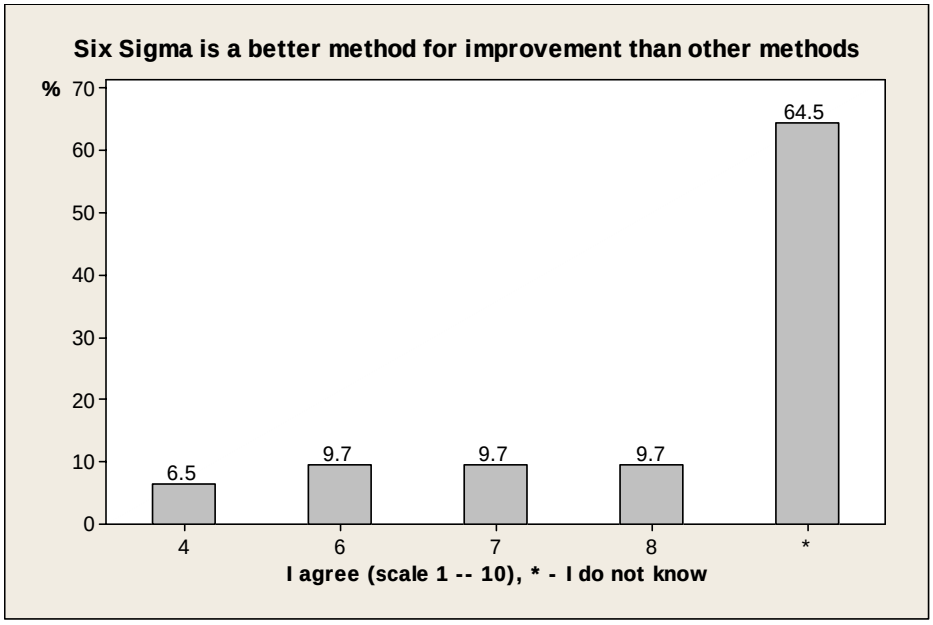

Figure 19. Result of survey statement 'Six Sigma is a better method for improvement than other methods'.

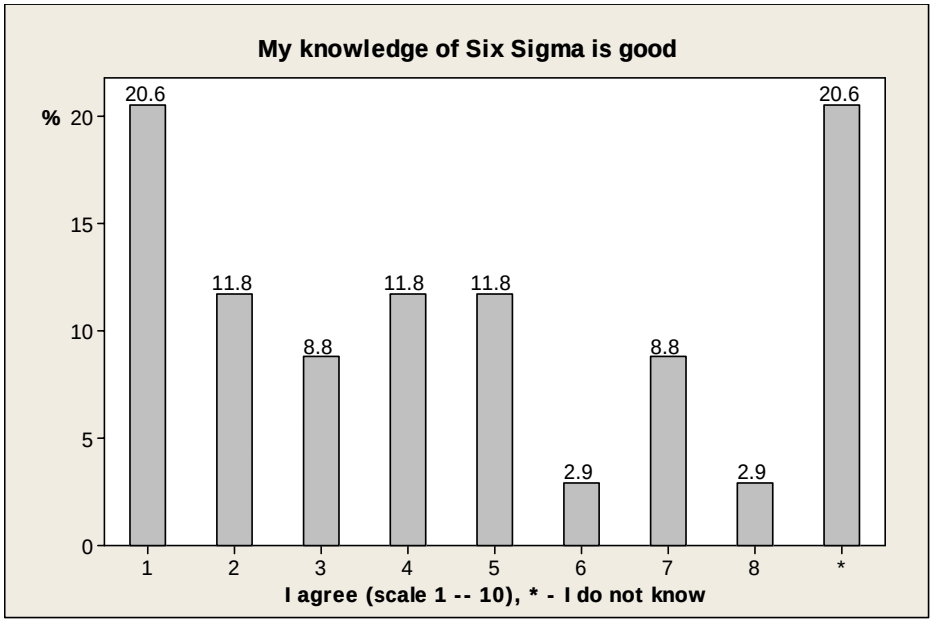

Figure 20. Result of survey statement 'My knowledge of Six Sigma is good'.

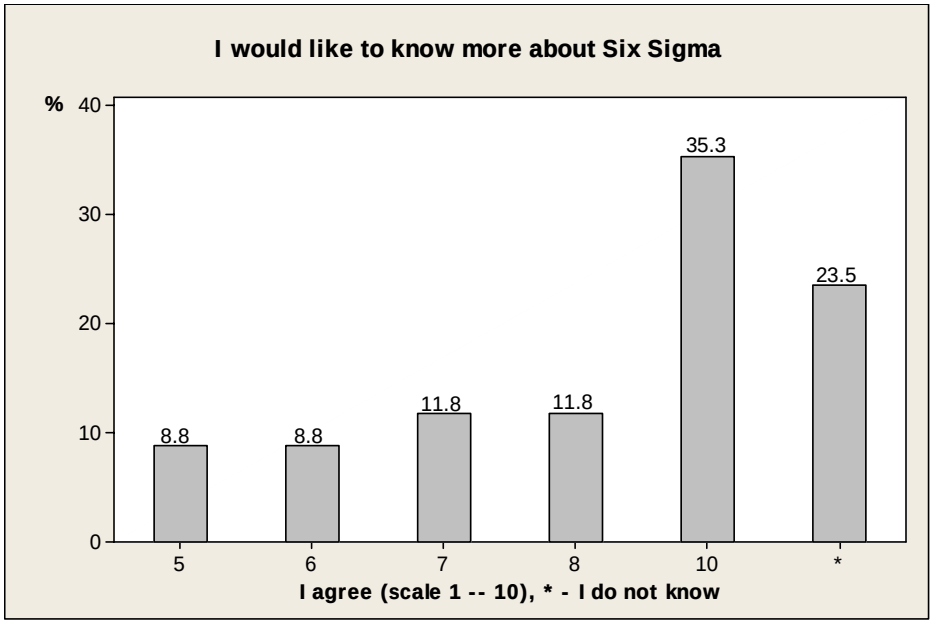

Figure 21. Result of survey statement 'I would like to know more about Six Sigma'.

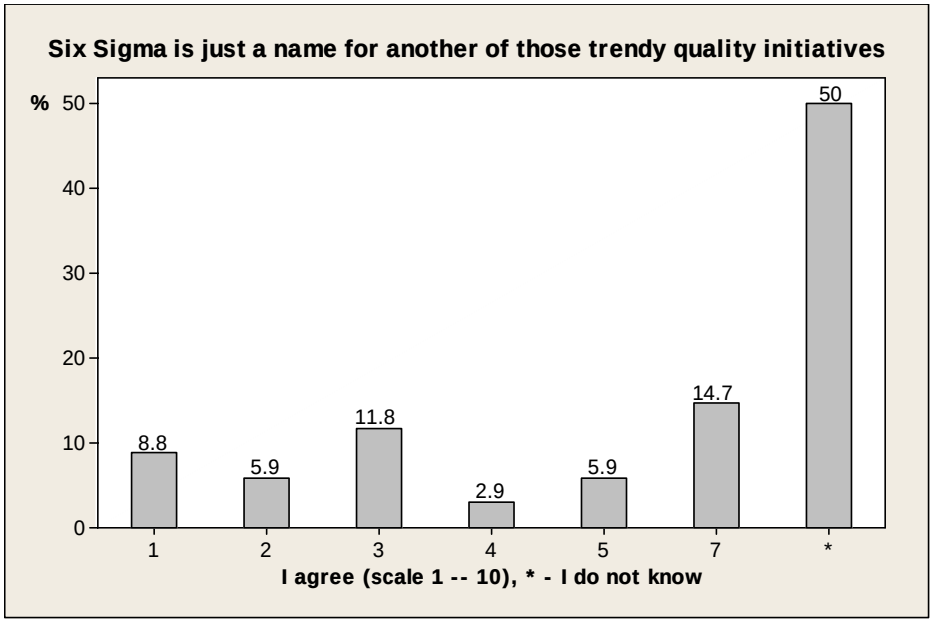

Figure 22. Result of survey statement 'Six Sigma is just a name for another of those trendy quality initiatives'.

The respondents' view, see Figure 20, of their own knowledge on Six Sigma is low. Only 14.6% (grade 6-8) think it is good, 64% (1-5) and 20.6% do not know their level of knowledge which means they have a low level of knowledge. All in all, the total level of knowledge must be interpreted as low. Considering this, the rest of the questions regarding Six Sigma, Figure 15 - Figure 22 are to great extent answered by 'I do not know'.

The respondents do not really know if Six Sigma requires a lot of training, see Figure 18, or if it is a better methodology for improvements than other methods, see Figure 19, neither if it is just another trendy initiative, see Figure 22.

Grading Six Sigma as a methodology for improvements in Figure 17 as many as 38.2% (6-10) gives a higher grade, but 58.8% do not know.

The statement 'I think that we should implement the Six Sigma strategy' in Figure 15 and 'It is possible to implement Six Sigma successfully in our organisation' in Figure 16 could be interpreted as a positive attitude towards the concept and the possibilities for implementation. The 'I do not know' responses could perhaps revile any view and attitude towards Six Sigma, but I think that if there was a negative attitude the natural response would have been a lower grade and not 'I do not know'.

The response in Figure 21 on 'I would like to more about Six Sigma' is satisfactory. 23.5% do not know which is a lame response, but almost all of the rest (67,7%) of the respondents rated 6 or higher. As many as 35.3% graded 10.

At least there is an obvious interest in Six Sigma. And to start with that is a great advantage.

5 Analysis

In this analysis Six Sigma implementation in the aviation industry, the status of Saab Avitronics, and the probable future situation are analyzed. The critical issues and major keys for success are summarized

This part of the work analyzes the results of the study in relation to the research questions and the theoretical and empirical findings. The theoretical research and the empirical findings are analysed and reflected upon. The existing theory is discussed in the reality of Saab Avitronics. The most critical issues and major keys for success are defined.

The analysis is structured around each of the research objectives defined in part 1.4.

5.1 Planning for marketing planning

The first question ‘How is marketing planning performed?’ was discussed in the theory part in part 2.2. The important steps of the marketing planning process in part 2.2 - Marketing audit and SWOT have been performed in this work; see part 4.1 and part 4.3 respectively.

The step ‘Marketing objectives’, see Figure 3, to define where the organisation would like to go is theoretically defined in the part 2.3.1 and 2.3.2 where the crucial phases and success factors during implementation are defined. What is stated there is what in theory would be the optimum way for implementation.

The ‘Marketing objectives’ for Saab Avitronics and where the organisation would like to go are further defined and analysed in this Analysis phase. The last three steps in the marketing planning process, see Figure 3, aiming to define ‘How do we get there?’ and ‘Are we on course?’

- the marketing decisions
- organisation and implementation, and
- control

are defined during the Analysis part of the investigation.

The overall objective of this work is to define recommendations for implementation of Six Sigma at Saab Avitronics.

5.2 Necessity of implementing Six Sigma

As stated in part 2.1 all companies have potential for improvements, and so does Saab Avitronics. The organisation needs to improve internally to meet the tougher marketing environment just to keep the market place. To keep the competitive advantage and to aim for bigger marketing shares just keep doing what is being done now is not enough.

Also Saab Avitronics has to deal with a world of declining product prices and compete with the best companies in the world. When implemented improvements in areas of technology, competence and processes or increasing market shares are no longer enough, something has to be done. The need for continuous improvement, as has been spoken of for so long, to become more effective, efficient and cheaper, is suddenly on top of the management agenda. Saab Avitronics needs to improve on all areas, fast and with visible results, both internally and for the customers.

Also the customers are requiring, if not yet Six Sigma methodology specifically, the use of statistics, root cause analysis, and measurable results, all items in the concept of Six Sigma.

Six Sigma is an improvement methodology aiming at reducing defects in business processes. It does not add anything new, but rather structures already proven methods in an organized way (Sörqvist, L. 2004). This fact reduces the likelihood of someone rejecting Six Sigma as a ‘hocus pocus’ which first has to be tested and proven elsewhere. Also the fact that companies have successfully used the methodology for twenty years is confidence-inspiring.

It is stated in part 4.1.1 that the Aerospace and Defence sector of the Fortune 500 are all using Six Sigma and have been for quite long (Marx, M. 2006). Most of Saab Avitronics customers, potential partners, and competitors are also using Six Sigma to various extents, see Table 4.

It is possible that an organisation, that has been using Six Sigma for some time, finds it natural or even unacceptable that a supplier, partner or customer does not work structurally with continual improvements.
When implementing Six Sigma, company internal improvements are most common. It usually starts by reducing scrap and waste, internal delays and other *low hanging fruits* – obvious improvement areas which are improved relatively easy. Constantly improving the company leads to the point in time where you need to affect and improve the relationship to others and the environment in which you act. The need to cooperate with the suppliers, partners, and customers in improvement initiatives arises.
Besides competing with the company's products it is an important competitive advantage being prepared to cooperate, being prepared to improve the company, and helping the customers to improve as concluded in part 2.4.

Andersson R. and Hammersberg P. point out in their paper "A Six Sigma framework enabling collaboration across company boundaries in supply chain" (2007) that one of the most significant paradigm shifts of modern business management is that businesses now compete as a supply chain rather than individual businesses (Christopher, M. 2000). This also may imply that Saab Avitronics will be *forced* into Six Sigma projects introduced by customers. As I interpret it, it would be wise to start preparing.

It is a fact that Saab Avitronics at the moment is not using any alternative methodology for improvement projects or at least not as successfully as desired.
I think it is safe to say that Six Sigma is here to stay and implementing Six Sigma is a prerequisite and necessity for success.

5.3 Prerequisites of Saab Avitronics

To define the reality of Saab Avitronics a marketing audit, a SWOT analysis and an internal survey were performed, see chapter 4. The result was the defined factors that would effect implementation and the company's ability to react on this.
As stated in part 4.1 the macro environmental effect on Saab Avitronics is what these factors in total have created; the need for improvement on all areas, the need to improve faster, and also the need for some structured method to accomplish this. Saab Avitronics is

a successful company, but up till now primarily due to a range of key competence areas in different engineering technologies. This is still vital, but as the environment is signaling, not enough for future success.
Six Sigma has been studied in the light of the special conditions that apply due to the fact that Saab Avitronics acts in the aviation industry. It is a harsh industry, like every other industry, but as the products are intended for flying purposes additional rules, regulations, and standards apply for safety reasons.
Planning for implementation of Six Sigma it is interesting to find out how a culture of continuous change can coexist with these stricter and controlled conditions.

The rules, regulations, and standards that affect Saab Avitronics, defined in part 4.2, can be grouped into the following categories depending on how they affect the implementation of Six Sigma;

- The quality management standards ISO 9001 and EN9100

  'The organisation shall continually improve the effectiveness of the quality management system through the use of the quality policy, quality objectives, audit results, analysis of data, corrective and preventive actions and management review' (ISO 9001:2000 §8.5.1).

  ISO 9001 and EN 9100 do not require Six Sigma, but do require that the company implements some method of measuring the effectiveness and efficiency of the company and methods for improving the result. This methodology is not required to be, but could be Six Sigma.

  According to the responsible for project management of internal projects at Saab Avitronics, the organisation has an obligation to notify the certification bureau, Det Norske Veritas, when major changes occur. This notification obligation is though quite light as a notification is enough as long as it is within the requirements of ISO 9001:2000 and it does not either require additional approval or acknowledge from Det Norske Veritas other than performed during the next audit. Praxis is that it is even acceptable to notify the changes during the next audit itself.

  The conclusion is that ISO 9001 and EN 9100 support the concept of Six Sigma and do not require special notification, but is within the scope of the standard. There

will be no additional costs concerning the ISO 9001 certificate and no additional procedures have to be implemented. Normal notification procedures are sufficient.

- Environmental; ISO 14000, laws, and customer requirements

  The conclusion here is the same as with ISO 9001:2000 and EN 9100:2003; ISO 14000 supports (the idea of) Six Sigma and does not require special treatment or notification, but is within the scope of the standard. ISO 14000 is voluntary for a company to implement, but managing environmental issues in general is not voluntary, but regulated by Swedish law. This means that regardless of ISO 14000 you are obliged to obey the environmental laws. Though, environmental requirements regulated by law or as required by customers, e.g. banned material, or disposal of products can not be altered in any case. Changing something, e.g. material or a process, with effect on the environment requires special considerations.

- Authorities for civil aviation; Part 21, Part 14

  Working with the civil aviation market requires additional efforts from the company. The management system has to be added some complementary procedures. Internal training has to be performed. Contact with the authorities and audits have to be planned. Changes in

  - project organisation or reporting methods
  - manufacturing methods, facilities or capacity for equipment under Part 21 or Part 145
  - or other significant changes such as ownership of company or change of company name shall be reported to the aviation authorities and approved before implementation.

- Customer requirements on processes and products

  Customer standards like the GRESS requirement require the company and the management system to fulfil some requirements on processes and products. Changes to this, if possible at all, require customer approval.

5.3.1 Marketing mix

How can the traditional term of marketing mix, by McCarthy called the '4Ps' (www.netmba.com/marketing/mix), be interpreted in this context?

The 'product P' is the Six Sigma concept itself, the offering to the organisation and, strangely enough, from the organisation itself. 'It is the most perfect and ambitious improvement program there is' (Sörqvist, L. 2006).

Six Sigma offers systematic problem solving and analysis based on sophisticated tools and methods.

Every time the product, the Six Sigma methodology, is used and a project is completed, you are paid back again, i.e. the more this product is used the more beneficial it is. The result, the benefits of using the product, is dependent of what it is used for. According to Sandholm Associates (2006) the average financial potential is 4-5 times the money spent on training and performance of the projects. The product can be found on the market, there are training courses, consultants, and a multitude of books. But to function well, this product has to be adapted to Saab Avitronics special needs and prerequisites, which is presented in the recommendations in chapter 6.

'Price-P' is the cost for the organisation of implementing Six Sigma. In this case the organisation shall sell this product to itself, but nevertheless it is important that the cost, the price, is right. A too high cost, or initial cost, might make the organisation hesitate even if the payback is probable and countable in the foreseeable future.

The price Saab Avitronics is willing to pay also sets the limits for the offering, the product-P. If the organisation is willing to pay more, parts of the offering can be redesigned to something different, e.g. training of additional Black Belts.

The cost (Price) is just a fraction of the potential savings, but the offering is a promise of something that will happen or might happen and there is always the risk that the ROI is zero. A reasonable cost will have to be calculated.

The 'promotion P':

The most important element of the promotion mix to be considered in the internal marketing is Communication. The Six Sigma concept needs to be communicated in different ways using different channels and during the different phases of the

implementation. The Saab Avitronics internal 'Communication Plan for Quality' (Eng, M. 2007) stated that it is important to consider geographical factors, cultural factors, and previous used concepts when communicating. Both informative and communicative channels should be used.

One of the first crucial communication activities is to create awareness of continuous improvements in general and why it is needed. It is probably the most important activity as it, by its mere existence - the awareness of the need – *by itself* eventually would create some sort of organisation and model for improvements, even if it would not be Six Sigma. And without an understanding of this need and the nature of continuous improvements any initiative to create a culture of continuous improvements is bound to fail. No matter how well designed process for improvements, appointed organisation and level of training, without awareness of why continuous improvements are needed this will not last.

'Place P' aims at having the right quantities of the product available at the right time and place, which for the Six Sigma concept means having training possibilities available when needed and the right amount of trained Black Belts and Green Belts when required.

Like many have argued (e.g. Booms and Bitner), also I think that '7Ps' is more appropriate than the '4Ps' for marketing. One of the additional Ps, the People-P, is crucial to the Six Sigma concept, also see part 2.3.2. The choice of employees involved in the implementation of the concept and once implemented, the performance of the projects means everything for the result and so the choice of Black Belts and Green Belts is important. Planning this, the 'People P' has to be considered twice. First it has to be considered during the implementation of the recommendations from this study and secondly when executing every single improvement project.

Process-P: The Six Sigma process chosen is the internally designed and adapted Business Improvement Process. This process is adapted to the already well implemented PROPS project methodology. This should ease the implementation as the level of recognition is high, e.g. the terminology of tollgates and milestones.

Also the process for implementation has been discussed. As Sörqvist, De Feo and Barnard all stated in Table 2, a five phase process is to recommend and should, as I see it, also be used by Saab Avitronics.

All in all the SWOT analysis of Saab Avitronics in Table 6 gives that the strengths and opportunities outweigh the weaknesses and threats when planning implementation of Six Sigma.
Some of the defined vital elements for implementation of Six Sigma in Table 3 are also defined as internal strengths;

- management commitment and financing of projects
- training and understanding of Six Sigma methodology, tools and technology
- one Six Sigma project already performed and the result speaks for itself, especially the financial benefits.

Looking at the weaknesses there are some that would be fairly simple to eliminate. The limited competence on statistics, Six Sigma methodology and tools is a matter of primarily training. The weakness of lack of available resources is also a matter of being decisive and allocates resources. This could easily be turned into strengths.
Lack of a driving force is just partly a truth. The driving force is there, but is related to the resource problem and is therefore not possible to act.
It is not a weakness that there already are many other improvement initiatives ongoing. The problem is that this may seem sufficient; many things are being fixed already and the need for a new methodology is vague. The weakness here is the lack of understanding; that fixing a problem is not the same as eliminating the root cause. The organisation already feels potent to take action, but looking beneath the surface not much ever changes. If it has, it has not been proven or calculated, i.e. there is a lack of focus on results and follow up, which are also defined as critical success factors in Table 3. Related to this and the most difficult one is the lack of improvement culture, the missing insight in continuous improvements, and what it takes to accomplish this.
Implementing Six Sigma would fulfill all the opportunities of which some are also requirements on Saab Avitronics. Customer requirements on measurements, statistics, and

improvements and also the requirement from Saab in the group-wide efficiency program have to be adhered to.

ISO 9001, EN 9100, and ISO 14000 all have requirements on measuring, continuous improvements and when appropriate also statistical methods. The implementations of these are not yet completely satisfactory. The consciousness of this has increased lately due to project needs, the need to improve in general, customer requirements on this topic, and a general *trend* or *awakening*. This creates a need for facts and data which in turn creates a need for methodologies for measuring and analysing.
The need to improve on already identified problem areas and the financial potential creates an urge for *something*. It is also advantageous that Six Sigma already is well known in the industry which creates possibilities to cooperate in improvement programs and also to benchmark.

Discussing Six Sigma this way raises the question why this has not been done a long time ago. If there are only advantages and opportunities what is stopping this from happening? It is maybe not the concept itself, not the results it would bring, but the difficulties that would arise on the way, the threats;
Geography itself is a hinder. Even if there are technical aids to overcome geography; Internet and video conference possibilities, the distance between the sites of Saab Avitronics limits what can be done. Common Black Belt training between sites is e.g. not possible and common Green Belt training gets expensive.
Also the cultural differences that come mainly from geography constitutes a threat; to the adaptation of the process itself, the implementation phases, and all the critical success factors they all have to be considered in the light of culture.
One of the greatest strengths and opportunities is the spread of Six Sigma on the market and in the industry, and the need and requirement it creates on implementation. But this also creates a threat. If Six Sigma gets a bad reputation before the program has reached the final phase of implementation, Sustain (see Table 2), it is sensitive to this kind of disturbance.

Increasing costs during implementation is a threat and the savings would rather quick have to outnumber the costs or the program would be the object of interest for closure. The success of Saab Avitronics could also be a threat to the implementation. Additional demanding customer projects require more resources that would not be available for the Six Sigma implementation and customer projects would have to be prioritized.

5.4 Implementation strategy

The research questions 'Which are the phases and success factors for successful implementation of Six Sigma?', see Table 1, has to be analysed in the light of the answers given by the research question 'What prerequisites and possible limitations for implementing Six Sigma and for continuous change are there at Saab Avitronics considering the *special conditions* that apply to the company?' and by applying the theory of implementation in part 2.3.

It is a necessity to take into consideration the five phases for implementation (Sörqvist et.al).
There is much to suggest that a five phase process for implementation of Six Sigma is suitable also for Saab Avitronics. Performing according to other models before, using only the three first phases like e.g. IBM (in part 2.3.1.) have failed.
A three phase model is what is found natural and how an improvement program usually closes. Controlling, following up, expanding, and sustaining, see Table 2, will in most cases not be activities considered. The improvement programs are demanding and resource consuming and once implemented normal activities are resumed or the next improvement program starts up. It is then common to fall back to the state before the change. In some cases it is noticed that the improvement initiative did not help the situation, but also in many cases no one notices! Completing the improvement program is considered a success itself and often the outcome is not measured and compared to the initial status. These last two (additional) phases from Table 2 will have impact twice for Saab Avitronics. First it is important to include these phases in the implementation of the Six Sigma concept. Secondly, the implementation plan and the process, BIP, have to include these two phases, Expansion and Integration, for every project that is executed.

One of the most famous cartoon quotes of all time is Walt Kelly's "We have met the enemy and he is us." It was first used as a poster for Earth Day 1970 (www.bpib.com/kelly.htm). The cartoon's sentiment, while specifically applied to a decidedly environmental message, can be applied to just about any human endeavour and also to that of failing improvement programs.

However, it's clear, both anecdotally and objectively, that process improvement efforts have failed far more often than they have succeeded and it's our own faults (Lefcowitz, M. 2007). Finalizing this study means that the Decide phase (see Figure 3) has been concluded and the 5 steps in the Decide phase defined by R. Normann (part 2.3.1) have been studied.
As mentioned in part 2.3.2 people are the most crucial part of implementation. People make up culture, which is one of the success factors defined in 2.3.2. Saab Avitronics having Product Areas in both Sweden and South Africa, by geography, have natural cultural differences. But even between the sites in Sweden there are cultural differences, which are noted on a daily basis in the cooperation between the sites.
Trompenaars F. and Hampden-Turner C. (1997) noted that there are always cultural differences among companies in the same country. The recommendations for implementation have to be planned under the consideration of culture, but more important is that culture in all parts of implementation has to be handled with care and sensitivity by those performing the implementation in practise.
The chosen implementation strategy for phase 3 – Implementation – must be ‘Partial implementation’, see part 2.3.1, creating a more natural implementation strategy and a suitable one for Saab Avitronics.

Studying the suggested parts of a marketing plan, by L. Sörqvist (2004) not only the recommendations in the next chapter, but also this entire investigation, with parts like the SWOT (part 4.3), is to be considered during implementation. The first parts create an insight in the concept and an environment in which the recommendations shall be performed.

By summarizing, the most important elements of Six Sigma from Table 3 and the success factors for implementation in part 2.3.2 give that the main focus for Saab Avitronics when implementing Six Sigma should be as Table 7 below shows.

Success factor	
Management commitment, see recommendations in part 6.3.	
Well defined process, see recommendations in part 6.3.	- for launching and implementation of the Six Sigma concept - for the improvement projects to be performed - adapted terminology
Powerful methods and tools, see recommendations in part 6.3.	- Business Improvement Process - Six Sigma methodology and tools
Training, see recommendations in part 6.3.	- Six Sigma training on different levels - communication and dialogue with the employees
Clear infrastructure including, see recommendations in part 6.3.	- defined resources - roles and responsibilities - organisation
Facts about the organisation see recommendations in part 6.3.	- the empirical findings in part 4.1, 4.3, and 4.4 defining the reality - measurable facts about the organisation and it's processes
Follow up and feedback, see recommendations in part 6.3.	- leadership interest in progress - clearly defined goals - communication of success stories

Table 7. Main focus for Saab Avitronics when implementing Six Sigma.

6 Conclusions & Recommendations

This study, defining the strategy of the implementation concept, what should happen and why, and also defining the implementation in theory gives good hopes on a successful implementation of Six Sigma at Saab Avitronics. This chapter presents the conclusions and recommendations as a result of the theoretical and empirical findings from chapter 2 and 4, and the analysis performed in chapter 5.

6.1 Response to the research objectives and questions

The research objectives and questions defined in part 1.4 have been studied and the study responded to these as presented in Table 8 below.

Part 6.2 defines the phases that are recommended during implementation of Six Sigma at Saab Avitronics.

The following part 6.3 defines the recommendations for implementation according to the main focus defined in Table 7. These factors should create the best possible environment and conditions for Six Sigma improvement programs to be performed in.

The chapter concludes with research implications; reflections on and contribution of the study and directions for future research in part 6.4.

Research objectives (part 1.4)	**Research questions (part 1.4)**	**The study responded to these questions by**
Decide upon the necessity of implementing Six Sigma at Saab Avitronics.	How spread is Six Sigma in the aviation industry?	stating the necessity of implementing Six Sigma in part 5.2 based mainly on theory from part 2.1 and 2.4 and empirical findings from part 4.1.1.
Define the prerequisites for implementation of Six Sigma at Saab Avitronics.	What prerequisites and possible limitations for implementing Six Sigma and for continuous change are there at Saab Avitronics considering the *special conditions* that apply to the company?	analysing the prerequisites of Saab Avitronics in part 5.3. The analysis is based on the empirical findings from the marketing audit in part 4.1, the SWOT analysis in part 4.3, the internal survey in part 4.4 and the *special conditions* in part 4.2.
Define a method and recommendations for implementation of Six Sigma.	Which are the phases and success factors for successful implementation of Six Sigma?	studying the optimum ways for implementation and the corresponding success factors analysing the implementation strategy in part 5.4 based on theory from part 2.3 and analysis in part 5.2 and 5.3.

Table 8. The study's response to the research objectives and questions.

6.2 Phases for implementation

The phases and main activities recommended for the implementation of the concept are presented in Table 9 below.

Phase	Name of phase	Main activities in phase
1	Plan	- present this investigation and have it approved - present the study recommendations to management and get approval to launch it - publish the Business Implementation Process - define a budget and a time schedule to correspond to the implementation plan. The budget shall include training, design of BIP, project management of implementation and tools (Minitab).
2	Pilot	- perform a number of pilot projects in one Product Area with focus on an internal problems and according to the criteria for choosing projects - perform extensive training - perform intensive communication, especially awareness training and success stories - update the Business Improvement Process, methodology and tools according to experience from the pilot projects
3	Implement	- all the defined success factors and corresponding activities according to part 5.4 shall be put in place - implementation shall be planned and performed according to 'Partial implementation' - resources shall be appointed and available - perform additional training - choose projects carefully and according to the defined criteria - perform improvement projects focusing on internal problems on all Product Areas if there are suitable projects according to the criteria - perform audit and evaluation of the implementation of Six Sigma and implement, if necessary, improvements and corrective actions
4	Expand	- continue choosing and performing improvement projects - widen the program for improvement and consider the areas of support processes, focus on customer satisfaction and suppliers.
5	Integrate	Improvements are now a natural part of the organisation. Check that - training in continuous improvement and Six Sigma is a natural part of new employees and a possibility for all - all processes have a natural connection to continuous improvements - the implementation program progresses as expected.

Table 9. **Implementation phases and main activities.**

Implementation of Six Sigma is the result of careful preparation and the intuition to understand complex patterns that results from it (Normann, R. *Reframing Business* 2001).

6.3 Recommendations for implementation

Management commitment

A successful Six Sigma implementation requires top management commitment and leadership. This is performed in the minds and actions of management. The change of minds will come eventually through the other activities planned, such as the awareness training and success stories from performed projects. But already from the start of the implementation management can show their support by;

- taking part in training
- dedicating resources and budget for improvement programs
- actively suggest areas for improvement
- asking for results and reports from improvement projects
- presenting results from improvement projects in different forums and reports.

Well defined process

Successful organisations use a defined model for improvements, rather than working "ad-hoc" (Eckes, G. 2003).

All Six Sigma improvement projects shall be performed according to Saab Avitronics Business Improvement Process.

Not all processes are appropriate targets for process improvement; because the cost of the improvement may be more expensive than the increased productivity they generate (Lefcowitz, M. 2007). This must be considered every time an area for improvement is a candidate for a Six Sigma project.

When stating that an area is not suitable for a Six Sigma project there are two possible scenarios:

1. The improvement area is a candidate for a Six Sigma project and the first phase of the project is decided to be performed. The planning and calculations during this phase shows that it is not cost effective to proceed and the project is closed.

2. The suggested area for improvement is not selected as a Six Sigma project as the defined criteria for a Six Sigma project are not fulfilled. The criteria shall include the special constraints discussed in part 4.2. Table 10 shows criteria that have to be considered when choosing an improvement project.

Product • customer requirement • authorities	Material • environmental effects • customer requirement
Organisation • facilities • resources for civil production	Processes • production processes • Nadcap • customer requirement

Table 10. **Criteria when choosing Six Sigma project.**

The terminology of Six Sigma is special and there are pros and cons' using it as it is. Implementing the concept and the vocabulary as is would be a simple solution. Using the original terminology simplifies talking to others about the improvement initiative and is also simplified at e.g. benchmarking. The sometimes strange vocabulary may strengthen the feeling of something new and fresh which can give extra passion to the implementation. The titles of the trained leaders of these project; Black Belts and Green Belts, can increase the status of these roles and also mark a step in the career. Just once again calling these project managers improvement leaders or similar, like during the previous and failing initiatives may be one of the factors making also this initiative to fail. Though, renaming the vocabulary and adapting it to the company culture can be necessary. The somewhat, as many may think, ridiculous naming originating from Japanese fighting art could complicate the implementation. But renaming might also have the opposite effect and might even be a bit suspicious, like you are trying to disguise what is being implemented

The vocabulary of the complete concept is an important decision. The terminology should be kept as close to the original as possible, as an adaptation of the terminology to the different cultures would not be an adaptation to each culture, but to an *average* Saab

Avitronics culture. It is therefore as good to keep the American one as far as the titles and the names of methods and tools. Also using implementation of the concept as a marketing advantage, the American original terminology is to prefer. Though in the adapted Business Improvement Process, terminology already used for project management shall be used.

Some adaptations to the terminology of statistics are suitable to implement in the daily conversation to the employees. The terminology suggested by D. Wheeler in Understanding variations (2000) is recommended, e.g.:

Instead of	**use**
Statistical Process Control	Methods of continual improvement
Control charts	Process behaviour charts
An in-control process	A predictable process
Out-of-control process	Unpredictable process

This internal language making it easier to communicate with the organisation shall be further developed and documented during the implementation.

Methods and tools

The attitude Six Sigma methodology endorses is an open-minded eagerness to study a process and learn from it and a willingness to correct one's misconceptions on the basis of experimental results and empirical feedback.
Well known methods and tools shall be chosen and connected to the Business Improvement Process.

Training

An extensive training program is needed including all levels in the organisation. A training plan for Six Sigma is dependent of the level of ambition; to what extent Six Sigma methodology is to be implemented and at what pace.

For Saab Avitronics the plan, see Table 11 below, is to:

- Create awareness for all employees of the improvement initiative.
- No huge marketing campaign for Six Sigma, but instead quickly perform a number of improvement projects on different sites (for "marketing" reasons and to show the power of Six Sigma).
- Educate a number of ambassadors, representative employees, from different sites and functional areas.
- Fewer Black Belts to support a greater amount of Green Belts rather than many Black Belts to be supported by Green Belts in the projects. One full-time Black Belt can support 5-10 Green Belt projects simultaneously.

The Six Sigma training system often consists of training using the tools and methods practically to achieve a better understanding. This also makes the methodology suitable for staff with a lower level of education.

Type of training	**Extent**	**Who**	**Quantity**
Management seminar	3 hours	Management	All
Black Belt training	20 days	Recommended from management	1 (full time)/100 employees and at least 1/site. To start with: 1 in Stockholm, 1 in ZA and 2 in Jönköping (already there).
Sponsor training	2 days	Recommended managers	2-3 per site
Green Belt training	5 days	Recommended from management	5 per site and full time Black Belt. To start with: 5 in Stockholm and ZA, 3 in Jönköping.
General Six Sigma/ BIP information	1-2 hours	All employees	All

Table 11. **Training matrix for Saab Avitronics.**

'It is important that we not only inform, but also communicate, thus creating a dialogue, involvement, and expectation' (Eng, M. 2007).

A communication plan must be defined including activities to:

- create awareness in general
- choose different channels for communication
- communicate progress during the different phases of implementation
- spread success stories

The main communication channels to be used should be SaabNet, group meetings and training sessions.

Infrastructure

The special circumstances regarding geography has to be considered and suitable solutions put in place.

There must be resources available and dedicated to Business Improvement Projects.

A project manager for the complete implementation program should be appointed.

The two employees already trained Black Belts should be made available for performing Business Improvement Projects.

Roles involved in the Business Improvement Process are already defined in the process and so the corresponding responsibilities and authorities.

Further more it is important to define the roles and responsibilities of management and the rest of the organisation, being responsible for choosing the projects and being customers to the outcome of the projects.

An internal project team shall always at least consist of the process leader on Product Area or Business Unit level and at least one of the actors in the process.

A BIP project shall have a (Black Belt or Green Belt) trained project manager. A Black Belt or Master Black Belt shall be appointed to the project for support. Also a Controller shall be appointed to the project. Depending on the task, a suitable project team is appointed.

The complete organisation for a Business Improvement Project is defined in the documented process.

Facts

Besides the training in and implementation of Six Sigma concept it is of vital importance that no project starts without knowledge of the process and tight sectors (Sörqvist, L. 2004). This requires that processes have defined and measurable goals and that methods for follow up have also been defined.

The Business Improvement Projects have to define the project objectives at the start of the project.

Follow up and feedback

The projects must be followed up regularly according to the project management principles at Saab Avitronics. Besides that, follow up from management must also be performed to show the importance of the projects and to enable communication.
Success stories and feedback from the projects must be communicated.

6.4 Reflections on and contribution of the study

The empirical part may have been affected by the fact that I work at Saab Avitronics, see part 3.1 for research methodology. I know the organisation very well, the environment in which it acts and what is required from it. Not much research was done to find that as the knowledge was already there. On the other hand it was also a constraint that I was too familiar with the organisation. Maybe that prevented me from documenting something important, something others would need to know, but was too obvious to me to be documented? Considering this condition I have at all times emphasised objectivity.

If this study was to be performed all over again I would try to find the success factors for implementation from some companies within the same industry and not only implementation in general. That would be interesting benchmarking studying the success factors at companies working in the same marketing environment and under the same *special conditions*, see part 4.2.

Also personal interviews with top management would be added to find out the expectations of implementing Six Sigma, which might have implications on the recommendations for implementation.

The work aims with the recommendations for implementation of Six Sigma for Saab Avitronics. It can be used when the Six Sigma initiative is to be launched. This is valuable to the company, but just as valuable is what is not written down in this work - the great knowledge and insights this research has given and the ways it can be used to contribute to a successful implementation.
This study can also contribute to the know-how and know-what, to others than those working at Saab Avitronics; like students studying the same topic or other companies planning their own implementation of Six Sigma.

Further research could be performed in various ways in the area of continuous improvements and Six Sigma.
A natural sequel following this study would be a case study after the implementation at Saab Avitronics has been performed and also the studying of implementing best practise theories like this implementation plan at various companies in different industries.

Most interesting would be to further study the success factors importance in different industries outside the aviation industry and compare the result between those industries. As the theory part in this study showed in Table 3, there are different views of what success factors are most important and as a result of this study also the ones most suitable for Saab Avitronics are chosen. It would be interesting to study what similarities that are present when choosing the same success factors for a company or within an industry. Further research in this area would make it possible to actually find selection criteria for each and everyone of the success factors.

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Appendix A - Internal Survey Questions

The internal survey will determine the level of knowledge of and attitudes to improvement processes, statistics and Six Sigma within the management team. The result of the survey will be used to plan implementation and will be part of the internal marketing plan.

General questions

At what site do you work?

- Jönköping
- Kista
- Linköping
- Järfälla
- Centurion
- Cape Town

In which Product Area do you work?

- Electronic Warfare
- Gripen Display and Reconnaissance Systems
- Recording and Monitoring Systems
- Utility and Mission Systems
- Marketing
- Common Operations
- I don’t know

In what area do you have your main responsibility?

- Development
- Production
- Purchasing
- Marketing
- Other

Improvement processes

We have a good way of implementing improvements.

We continuously improve the internal processes.

We need a structured method for improvement projects.

Statistics

We use statistical methods.

Our knowledge of statistical methods is good.

Statistical methods are necessary for our kind of business.

We need to use statistical methods at Saab Avitronics.

My own knowledge of statistical methods is good.

Statistical methods are necessary for any kind of business.

BIP

I have heard of a successful improvement project at Avitronics.

I have knowledge of Saab Avitronics process BIP.

Six Sigma

I think that SaabAvitronics should implement the Six Sigma strategy.

It is possible to implement Six Sigma successfully in our organisation.

How would you value Six Sigma as a method for improvements as a whole?

Six Sigma requires a lot of training.

Six Sigma is a better method for improvements than other methods.

My knowledge of Six Sigma is good.

Our customers have implemented Six Sigma.

I would like to know more about Six Sigma.

Six Sigma is just a name for another of those trendy quality initiatives.