Lean Six Sigma
– a way to make the supply chain resilient and robust

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Abstract

Purpose – This paper discusses how Lean Six Sigma companies can work to create resilience and robustness in the supply chain.

Methodology/approach – A case study in four companies with observations and face-to-face interviews has been conducted.

Findings – Quality tools and methods are very effective to make the supply chain processes robust and less risky. It has been indicated that Lean Six Sigma companies are robust and have some degree of resilience. It is also important to re-invest in activities that make the entire supply chain resilient. The savings generated from the Lean Six Sigma might be re-invested in risk prevention and mitigation solutions as to create redundancies in the supply chain. Sales and operations plans may be more structured and well worked-out in order to be resilient. Different professions and staff from different companies could be represented in the same training *"wave"* which can build bridges between departments, factories and, also, between suppliers and customers. In order to fulfil the highest quality at the lowest total cost, the right quality and resilience must be designed from the beginning. Integrating Lean Six Sigma with suppliers and customers in designing products and processes together in order to strive for resilience will be the next challenge.

Originality/value – This paper provides guidance to organisations regarding the applicability and properties of robustness and resilience in the supply chain. The paper will also serve as a basis for further research in this area, focusing on practical experiences of ways to make the supply chain resilient and robust.
Keywords –Lean, Six Sigma, supply chain management, resilient, robust, demand chain risk.
Paper type – Case study.

Introduction

Today's business environment is characterised by extremely tight competition between companies, countries and even entire continents. Companies are forced to constantly lean down, reduce costs and outperform. Efficiency and cost-based competition have been highlighted and production is increasingly being transferred to countries with low labour cost. The length and complexity of the supply chain tends to increase, rather than diminish, thereby making the chain riskier and less predictable and hence more vulnerable. At the same time, customers are becoming increasingly demanding. Many company failures can be traced back to an inability to adapt rapidly to changing market expectations (Hoole, 2005; Eriksson, 2003). According to Ericsson (2003) and George et al. (2004) we are living through times of rapid change and the rate of change is increasing. We must recognise change and identify its impact on competitiveness and set out a strategy for mastering it across the supply chain. Consumer products and services now need to take individual life-styles into account – one size no longer fits all. Today supply chain managers are being confronted with a vast array of unconventional risk-related issues, major congestion on roads, in cities and harbours, critical demands forced by a lean supply chain, just-in-time systems, sourcing products halfway around the world, etc. Adding to the complexity of the supply chain management function is a host of uncertainties that have reached levels never imagined before, according to the logistics organisation (the Council of Supply Chain Management Professionals).

How can organisations prepare for crisis situations such as those described above and even gain strength from shock occurrences? They can build resilient supply chains that are capable of withstanding and recovering quickly from unexpected disruptions. Flexibility, redundancy and a risk management culture must be built into the supply chain (Sheffi, 2005). There is however little formal risk management in the supply chain today (Christopher et al. 2003). According to Antonovsky (1987), organisations need to be flexible and resilient because of the supply chain being unpredictable. Similar findings are supported by Christopher and Peck (2004) as they argue: *"In today's uncertain and turbulent markets, supply chain vulnerability has become an issue of significance for many companies. As supply chains become more complex as a result of global sourcing and the continued trend to leaning-down, supply chain risk increases."* The challenge to business today is to create resilient and robust supply chains in order to manage and mitigate the risk and vulnerability, which are caused by longer, leaner and more complex supply chains. Six Sigma is a method to identify customer requirements and fulfil them without unnecessary variation (George et al., 2004). Efficient logistics management requires that unpredictable variations and uncertainties are minimised.

According to Sheffi (2007) and Cranfield School of Management (2003) supply chain resilience is a new and largely unexplored area of management research. Today there are no clear management guidelines, models, or theories for business resilience. Central to the risk debate are the notions of robustness and resilience. Instinctively we would argue that a risk management strategy and a combined Lean Six Sigma management philosophy should aim to create and maintain a supply chain that is both robust and resilient. Recent research has highlighted that the sources of risk in supply chains might be mitigated and managed by a combined quality management philosophy.

It has been indicated in recent articles that the Six Sigma framework focuses on mitigating risks and Lean Six Sigma companies show risk awareness as well as robustness, but today this it is not enough. They must also be resilient. The companies might also use the surplus that Six Sigma projects generate and reinvest this thus making the supply chain and the organisation resilient (Rutherford and Christopher, 2004). The question remains how the

companies should organise the work at a strategic level in order to be both robust and resilient. This leads to the following research question:

> *What methods are suitable to increase resilience and robustness in the supply chain?*

Resilience versus robustness

The Latin root of the word resilience is *"resilio",* which means to jump backwards. The dinosaurs were very robust but not resilient; in contrast, the rat is resilient. Charles Darwin stated: *"It is not the strongest of the species that survive nor the most intelligent, but the most responsive to change."* In materials science, *resilience* represents "*the ability of material to recover its original shape following a deformation."* For enterprises, it measures their ability and the speed at which they can return to their normal operation level, or move to a new more desirable state after disruptions (Christopher and Peck, 2004). According to Sheffi (2007) resilience measures the ability and speed at which the company can return to normal performance level (production, services, fill rate, etc.) after a disruption.

Based on dictionary definitions, robustness is understood to mean strong, sturdy and constitutionally healthy. Thus a robust process might be expected to produce consistent results with little variation in output. Resilience is the ability of a system to return to its original [or desired] state after being disturbed. In the context of business today a resilient supply chain must also be adaptable, as the desired state may be different from the original. Robust processes may be strong but they are not by definition adaptable (Rutherford and Christopher, 2004).

The quality management way

Variation in any process is an issue. If everything were constant and predictable, there would be few problems in business. The challenges arise because of variations. Hence, if variation can be reduced and monitored, the consistency of the output could probably be guaranteed and reliable. The quality management tools and methods as process control and design of experiments become the means by which variation in output is reduced and afterwards monitored.

The Six Sigma management philosophy searched for a robust quantitative method that would drive variation out of processes and thus guarantee the reliability of their products (Eckes, 2001). The company Ericsson AB defines Six Sigma as *"A strategic initiative to reduce costs of poor quality and customer dissatisfaction using a systematic problem solving methodology emphasising variation reduction"*. Six Sigma can be seen as a management philosophy, which consist of a framework (Magnusson et al., 2003), see figure 1.

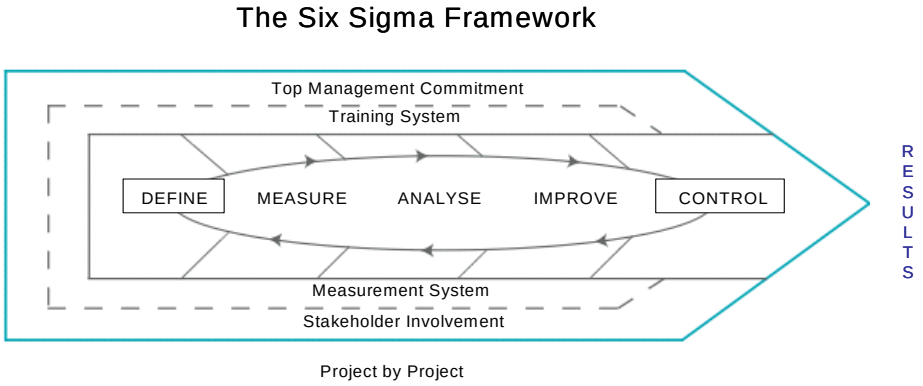

Figure 1 *The Framework of Six Sigma (Magnusson et al., 2003).*

Important features and framework of Six Sigma at Ericsson AB are the focus on cost reduction, variation reduction, customer satisfaction, systematic training in problem solving, common problem solving language, improvement agents, (Black Belts, Green Belts, etc), strategic edge/top management involvement, as well as a measurement system for identifying new improvement projects and for having an overall view on the organisation, over time. Six Sigma could also be described as a data driven improvement programme for reducing variation, which focuses on continuous and breakthrough improvements (Magnusson et al., 2003). Improvement projects are driven in a wide range of areas and at different levels of complexity, in order to bring processes under control and to improve process capability by reducing variability. According to Ericsson AB the objectives of Six Sigma is to reduce unwanted variability that results in cost reductions and increased customer satisfaction. The reduced variability may also lead to improved delivery precisions and yield, which also lead to decreased risks and improved robustness.

Six Sigma tools and techniques enable the proper execution of the DMAIC cycle and ensure that decisions are based on qualitative and hard quantitative evidence.

Lean and Six Sigma are two of the most popular management philosophies, but why not take the best of both worlds? Some companies have merged Six Sigma and Lean practices (Magnusson et al., 2003). Recently, the term Lean Six Sigma has been put forward by George et al. (2004). They specifically claim: "*Lean Six Sigma helps companies flourish in a new world, where customers expect no defects and fast delivery at the minimal cost.*" Furthermore Lean needs Six Sigma and Six Sigma need Lean (Sörqvist and Höglund, 2007), but the power of integrating Lean and Six Sigma principles is quite dramatic. Lean philosophy takes care of waste across all processes and focuses on speed, whereas Six Sigma focuses on design, eliminating defects and driving out process variation (Gerge, 2002; Andersson et al., 2006). By applying these philosophies simultaneously, organisations can improve customer satisfaction, increase process speed and quality of product and service, whilst reducing cost and invested capital in ways that make the supply chain even more robust and resilient.

Lean Six Sigma in the supply chain

The last year some companies have extended Lean and Six Sigma in the supply chain. Experience from Lean Six Sigma companies today indicates that after a few years the companies have improved considerably within the focal organisation and have started to realise that it is their suppliers who create problems for the company. In approximately one third of the Six Sigma projects the main root cause of the problems will be found outside the focal company and if the projects expanded outside a department or better still, outside

the company, the logistics objectives, risk mitigation and the savings were additionally improved. The next step will be to expand the Lean Six Sigma outside the company (Andersson and Torstensson, 2006).

Goldsby and Martichenko (2005) define Lean Six Sigma in the supply chain as: "*The elimination of waste though disciplined effort to understand and reduce variation, while increasing speed and flow in the supply chain".* It is about looking closer at the seven logistics wastes, inventory, transportation, space and facilities, time, packaging, administration and knowledge. If Six Sigma tools and methods are applied to squeeze out variation in time, lead-times might become more reliable and safety stock levels can be reduced. It would appear that Six Sigma offers a route to creating more robust supply chain processes that reduce the risk of non-conformance and hence produce a more reliable output. In a steady world this might be enough, but today faced with unpredictable events our supply chain processes also need to be agile and responsive. On the other hand if enterprises have control over their supply chain processes they are in a good position to control and monitor a shift in output. The key lies with Lean Six Sigma process control and monitoring. But to achieve and sustain the shift we might need some spare capacity (Christopher and Rutherford, 2004).

Method

A case study in four companies has been performed, with observations and face-to-face interviews. The findings are supported empirically by on-site interviews and by observations in three of the companies. The selection of companies was made with the following criteria: the companies must have used Six Sigma for at least two years, have run more than ten Six Sigma projects, and have applied Lean and TQM philosophies. All the companies were selected from a Six Sigma association. The selected companies were: Volvo (two people), SKF (five people), Ericsson (five people) and AlfaLaval (one person). All companies were using a typical Six Sigma philosophy and two of them had previously a typical Lean philosophy. Today all of the companies combine Lean and Six Sigma. All the companies accepted to participate in the study and the interview response rate was 100 %. Interviews were performed with Six Sigma Champions in three companies, Black-Belts in four companies, Lean coordinators in one company, Quality managers in two companies and division managers in one company. Different respondents have been asked the same questions, notes were written down and the interviews were tape-recorded. In Ericsson and SKF more time has been spent with observations and interviews. The material has been analysed through theories, methodologies and tools from the disciplines of TQM, Lean, Agility, Six Sigma, supply chain management and risk management. The used definitions of Lean and Six Sigma are from Andersson et al. (2006).

Case study

Ericsson has been exposed to a number of risks and incidents since 1990 as a result of outsourcing and leaning down, as well as having longer and more complex supply chains. A catalyser experience, an accident at a supplier's, resulted in a shift in perception regarding risk management. This accident has been widely reported (Norrman and Jansson 2004, ;Wall Street Journal, 2001). A stroke of lightning caused a small fire at one of Ericsson's smaller subcontractors, who also supplied their competitor, Nokia. From a plant perspective the fire was negligible, but the thunderstorm also caused some power fluctuation and there was no spare diesel motor to power the fan to meet Clean Rooms requirements. The consequence of the fan stopping was that the plant produced

contaminated chips, and Ericsson had no other supplier of that special chip. The real impact was unsatisfactory quality for six months, costing the company 400 billion dollars. The company lost many months of production as a result of not taking swift and decisive action. In contrast, Nokia had more than one supplier and acted much more quickly and firmly – for them the accident was negligible. The price of not being resilient in this situation was for Ericsson a production loss of mobile phones, which lasted many months, and the accident may have triggered a withdrawal from the mobile phone terminal business (Norrman and Jansson, 2004).

Today Ericsson knows that the leaner, more integrated and longer a supply chain is, the more uncertain, and sensitive to accidents it is. Modern supply chains are more vulnerable due to factors such as outsourcing, fewer suppliers, reduced buffers and increased demand (Svensson, 2000). The above-mentioned accident triggered off changes at Ericsson, to improve analyses, to assess and manage risk, and to act more swiftly.

The Ericsson facility in Borås, Sweden, is the world's leading manufacturer of microwave radio systems, and holds over 40 % of the short haul market, far more than any competitor. The factory is one of the best in the Ericsson Group. An international survey, Probe, rated the Ericsson plant in Borås as World Class in the survey's top category. Ericsson's Six Sigma Centre with training responsibility for the entire Ericsson Group is located in Borås. The factory has carried out many Six Sigma projects and has been applying the Lean Philosophy in order to make the company's processes robust (Andersson et al., 2006; Andersson and Torstensson, 2006). Today the Black-Belts are even trying to include robustness and resilience when working on Six Sigma or design for Six Sigma projects. For example, a Six Sigma project was initiated due to the need of improved delivery precision and flexibility. The situation was that the Supply Unit wanted to store a minimum of products, whereas the Market Unit preferred to offer prompt delivery, see figure 2.

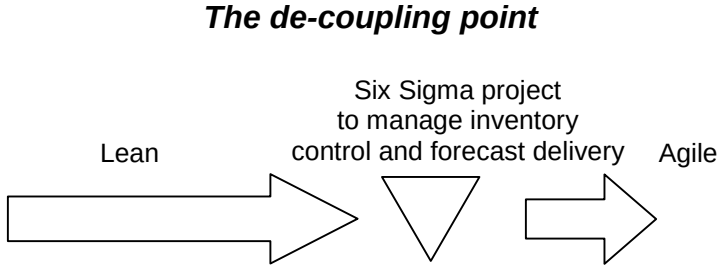

Figure 2 *The Supply Unit does not want to have Products in Stock, whereas The Market Unit Wants to Have a Large Stock.*

In order to find the root causes of the problem, in-depth interviews were conducted both internally and externally. More than half of the problems were found to be the result of incorrect forecasting. The suppliers complained of regularly changed order quantities. The main preventative solution to these problems was to construct an SPC (Statistic Process Control) Chart, and an EWMA (Exponential Weighted Moving Average) Chart.

If, for example, the EWMA chart had been used in 2001 when customer demand declined, Ericsson in Borås would have been able to react up to six months earlier. The chart can be used to monitor risk, e.g. new customers entering the market, customers changing their purchase behaviour, a decline in demand and incidents involving local environmental risk in a region. In 2006 Ericsson saw that the chart did not follow standard patterns: it issued a warning week 46. Now this can be linked to a decline in the Indian and Malaysian markets. Ericsson could react much faster thanks to the chart. Supply risks have also been avoided thanks to the chart and related procedures. Today the chart is used for making decisions

using facts to forecast the capacity of activities, from a day-to-day basis to a monthly basis, e.g. staff training, machines loads and storage space. Earlier, supply managers and departmental managers made regular corrections and modifications to the work plan. The earlier forecast error figure was 20 % and variations in order plans were over 20 % (between actual demand and delivered product). Today, inaccurate delivery precision is only a few percent and variation is less than five percent. The order plans have become much more robust. For example, in 2005 Ericsson changed their forecasts two times per supplier per year; earlier there were twelve changes or more. The price to be paid for robustness and resilience in dealing with changing customer behaviour was the investment in the Six Sigma project, the construction of the Chart and related routines. Ericsson re-invested in activities that made the supply chain even more resilient in order to reduce supply chain risks and to become more agile. In order to let the Chart do the job, a changed behaviour was needed, i.e. staff needed training.

Another way of achieving robustness is to store a standard product, gaining buffer time in which to deal with changed customer demand and to handle less frequently ordered items. The company has re-invested in additional risk mitigation procedures and ways of monitoring solutions, as well as in collaboration activities to improve resilience in the supply chain. Today the policy is that everyone must be a risk manager.

After the fire, Ericsson reorganised and introduced new tools. The new approach includes analysing, assessing and managing risks along the supply chain, and means working closer with suppliers in order to minimise risk and to find efficient levels of risk and prevention solutions. Discussions with suppliers are initiated and analyses made of their agile performance, i.e. the suppliers' ability to react to changing/changed conditions, particularly reaction time, swiftness of response and ability to handle large order quantities. All suppliers must declare how much and how fast they can supply on a weekly basis in MRP (Medium Range Plan) and SDC (Secured Delivery Capability), see figure 3. Discussions are continuously held with suppliers about future risks, supply, demand and environmental risks in particular. Based on that, a pre-S&OP (Sales and Operation Plan) is conducted. The next step is to perform a Sales and Operation Plan by checking the EWMA Chart and collecting information from the Supply and Market units. Then a Pre-TDM (Tactical Dimension Meeting) is held. Simulation and scenario events are used to map the flow between Ericsson and their suppliers in order to understand risk sources and critical paths and to try to understand the impact of any accident. Finally an MRP and SDC are sent to the suppliers, outlining how much has to be supplied each week as well as how much can be changed from the target supply. An annual forecast plan for each month is also provided. This procedure is repeated every month.

The outcome of the procedure has so far resulted in Ericsson in Borås having made joint re-investments in machinery with some suppliers in strategically important areas. Additional suppliers have also been contracted to make up for redundancies in some regions. A future effective solution is to use an S&OP team to create suitable Six Sigma projects in the supply chain. This team usually has the best overviews of lead times, demand variations and other related risks in the supply chain. Today the EWMA Chart, MRP and SDC are employed for making decisions, using facts to forecast the capacity of almost all activities, from a day-to-day basis to a year-to-year basis, e.g. investment, staff training, machines loads and storage space. Earlier, load and forecasting plans were based on decisions by departmental managers, supply and logistics managers, the managing director and market companies. It was management by correction, and the more corrections, the less precision. Ericsson in Borås found that it was better to steer the car using the rear view mirror.

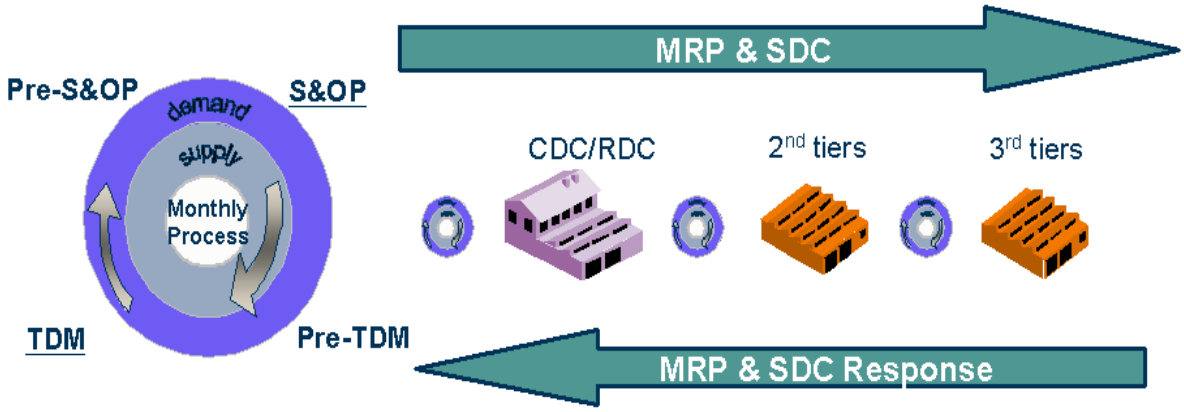

Figure 3 *The Figure Describes the Procedure Analysing, Assessing and Managing Risks along the Supply Chain. MRP (Medium Range Plan), MRF (Medium Range Forecast), TDM (Tactical Dimension Meeting), S&OP (Sales and Operation Plan), CDC (Customer Distribution Centre), RDC (Regional Distribution Centre), SDC (Secured Delivery Capability).*

Lead-time and delivery precision are vital to meeting customer demands. The postponement strategy and customisation of the product is carried out just before delivery. Another strategy is to give the finishing touch to the product just before delivery to the customers as well as to have suppliers of late refine parts in a near region. To sum up, the stored products in the de-coupling point can sustain common as well as special causes of variation or risks up to a few weeks. The SPC chart and the procedure above (MRP and SDC) can detect special causes of risk in a month, thus making Ericsson factory in Borås robust and more resilient than before.

Today, the demand for resilience may be even more pronounced. The entire Ericsson division may follow the good examples with Lean Six Sigma philosophy at the factory in Borås. On the 16th of October 2007, - Carl-Henric Svanberg (CEO) declared that the operating income and cash flow would be lower than expected. The sales decline resulted in an unfavourable business mix and damaged the company's margins (www.CNNMoney.com, 2007). The shareholder value fell by over 20 percent in a day and by over 50 percent in four months. Ericsson's facility in Borås could see this sales decline first in Ericsson division, thanks to the EWMA chart. If Ericsson had been connected to the Six Sigma framework and projects with the company's strategy and S&OP caps as well as training more Black-Belts in the entire Ericsson division as SKF has done, there might not have been such a dramatic decreased shareholder value and the recovery might have been effectuated more rapidly. This standpoint is also supported by Peter Häyhänen, Champion Black-Belt, responsible for Ericsson's Six Sigma reproducing in division.

Today SKF has integrated Lean, TQM and Six Sigma. According to Tom Johnstone (CEO), Six Sigma is the best philosophy as it contains the process, the tools and the way of working that helps SKF set a new standard in the market place, but there is a need for a change of culture. One of the objectives is to spread it as an evolution by showing great project savings and improved strategy objectives. In three years the hard savings have been over 60 million Euros. Over 250 Black-Belts and almost 1 500 Green-Belts have been trained. The Black-Belts' goals are to accomplish two fulltime improvement projects in a year, in order to improve SKF's strategy objectives. After two years' fulltime improvement, the leader will often be a future leader in some part of SKF, thus spreading the culture and language. According to the division Quality Manager Claes Rhenberg, the atmosphere has been improved thanks to the fact that decisions based on facts do not appear as emotionally charged to the staff. Furthermore Six Sigma has given SKF a common language which has built bridges between departments, factories and, also,

between suppliers and customers. For instance, SKF has developed application solutions together with Caterpillar, which also uses Six Sigma. SKF has also carried out Six Sigma projects together with suppliers in their factory. Today the companies Caterpillar, General-Electric and Honeywell have even made it a requirement to work with Six Sigma.

SKF Green-Belt training differs from other organisations' (Sörqvist and Höglund, 2007). First, it has a duration of ten days; other companies often use four to eight days. Second, a comprehensive project with a certain amount of saving is required, which is not common in the Green-Belt training. Many Six Sigma companies have no Green-Belt training or for managers only. Third, different professions are represented in the same training *"wave"*, which creates networks based on personal relationships, e.g. managers, supply chain staff, engineers, supervisors, operators, as well as front line staff sharing knowledge. According to Michael Jacobson, Master Black-Belt, the visibility and the overall picture of the company's processes have been improved, thanks to the cross-function staff participation. SKF has invested much in training front-line staff and operators in risk management and improvement strategies and tools. Due to the importance of spotting the risks in the beginning, about 20 percent of the participators in the Green-Belt training are front-line staff. SKF tries to evolve a risk management culture by creating common values, culture and rules, especially a culture that supports resilience, e.g. when formal policies and routines do not cover up, all staff members are expected to be innovative and enterprising in solving problems.

In the future, the processes must acquire additional improvements. Tom Johnstone has stressed the importance of design for Six Sigma, *"it is not easy to fulfil the highest quality at the lowest cost, if the right quality has not been designed from beginning"*. Integrating Six Sigma with suppliers and customers into designing products and processes together will be the next challenge. This view is shared by Niklas Lövmark, Master Black-Belt at Alfa Laval.

There is an insurance department at SKF, which has a risk survey view of the whole SKF; today being a quality manager means trying to prevent risks. Cleas Rhenberg has regular meetings with the insurance department and quality managers at all units about future risks. If something has occurred or could, Black-Belts will be set in to solve it. Usually, the solution and prevention of the problems or risks can be divided into three areas: quantitative, qualitative and innovation problem solution. For quantitative problems -Six Sigma philosophy is often most suitable. Lean philosophy is to be recommended when the solution is of a qualitative nature (but they have integrated some tools and methods from both philosophies), and for innovation, Design for Six Sigma - (Sörqvist and Höglund, 2007). Both Ericsson and SKF have this approach.

At SKF both strategic and tactical Six Sigma projects are performed. First of all the projects are passed through a filter, which visualises the most suitable project model and project. There are four different project approaches; *"Just do it-"*, a design for Six Sigma-, a Lean- or a Six Sigma project. One drawback of the Six Sigma project is that it often takes 3-9 months to finish. In general, the identification of suitable Six Sigma projects is visualised by breaking down a SKF vision to division strategy objectives and, finally, to business unit strategy objectives. The projects are connected to the strategic business plan activities, see figure 4.

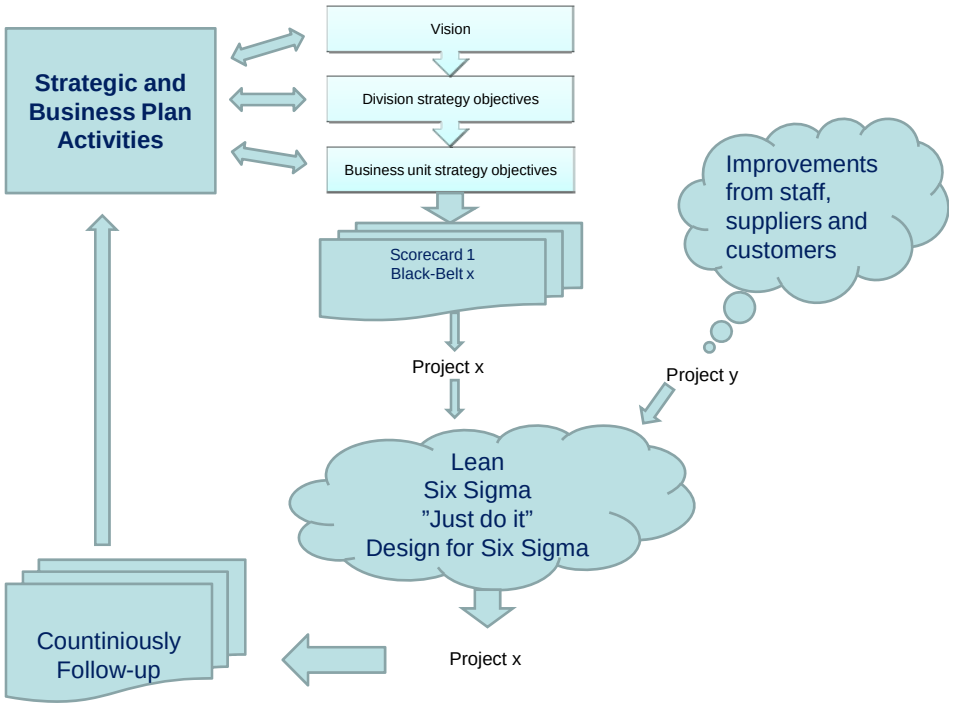

Figure 4 *The Six Sigma project is often initiated by breaking down vision, strategies and objectives. The improvement projects are a part of the strategic business plan activities.*

SKF, Alfa-Laval, Volvo and SKF have aligned Lean and Six Sigma, even if they have Lean, Kaizen and Six Sigma projects they make use of the Six Sigma philosophy and DMAIC methodology as a common platform in all projects.

If there is a crisis in SKF or in the supply/demand chain, some of the 250 Black-Belts could be applied to solve it, but a drawback in Six Sigma projects is that they take an average of 6 months to complete. On the other hand, Volvo cars and Ericsson have performed Six Sigma projects in less than two weeks.

Volvo has performed Six Sigma projects in five days through their suppliers. Even if the improvement projects were more of a qualitative nature (Kaizen project), the DMAIC was used. The performance and complexity of the projects were the same as ordinary Six Sigma project. Ericsson in Borås has performed two Six Sigma projects in three days. The preparation before starting the project was about 10 hours in 2 weeks, but it could have been in two days. Afterwards, a few hours were devoted to controlling the process, according to Anders Näslid, Master Black-Belt, see figure 5 below. The success story of these projects has escalated into an additional five Six Sigma projects, which have been planned with short notice. The following examples supported that if there is an internal or external disturbance to the supply chain the Black-Belts could be seen as a spare capacity, as a fire fighter.

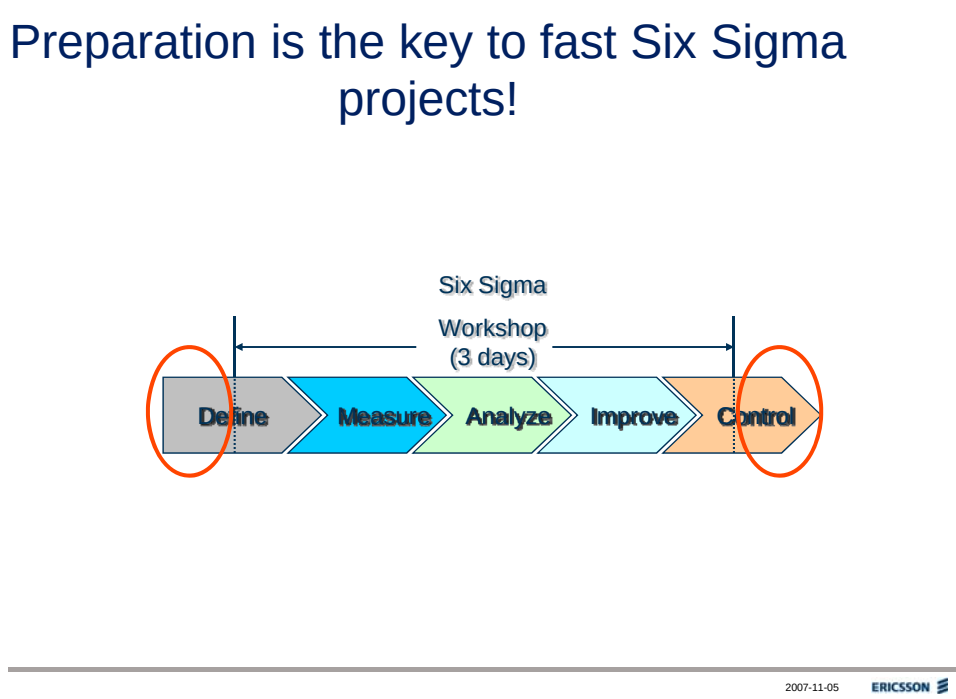

Figure 5 *By being prepared and having allocated staff and resources in three days, the lead-time for a Six Sigma project could be decreased pragmatically. Some vital staff members were forced to be available in short time if the project group should need them. The circle before and after the workshop explains that some hours were used before and after the workshop thus within the Six Sigma project*

Conclusion

It has been indicated that Lean Six Sigma companies are robust and have some degree of resilience. But it is important to re-invest in activities that make the supply chain more resilient. The savings generated from the Lean Six Sigma might be used for that purpose, especially re-investment in risk prevention and mitigation solutions. Different professions and staff from different companies could be represented in the same training *"wave"*, in order to create a risk management culture, common values, culture and rules, especially a culture that supports resilience. This can build bridges between departments, factories and, also, between suppliers and customers.

Other ways to be more resilient is to use statistical process charts to monitor risks. A standard common produced product could serve as a buffer if some risks occur, but it might be a better solution to strive for redundancies. This could be to have two suppliers, more machines etc. Sales and Operations Plans may be more structured and well worked-out i.e. using simulation, scenario events, understanding critical paths and declare to the suppliers how much has to be supplied each week as well as how much this amount could be changed from the target. Other things to do are to train more Black-Belts and Green-Belts in the focal company and the supply chain, especially Sales and Operation Plan staff. If there is an internal or external disturbance to the supply chain the Black-Belts could be called in to solve it. It has also been indicated that it is important to have and perform different performance and approaches of projects, but the Six Sigma road map may be used in all project models. It is important to have a project approach that takes a few days to finish. The right quality and resilience must be designed from the beginning. Integrating

Six Sigma with suppliers and customers into designing products and processes together will be the next challenge with a view to resilience.

The postponement strategy and to give the finishing touch to the product just before delivery to the customers as well as to have suppliers of late refine parts in a near region and other logistics strategies are important to be robust and resilient.

Due to the fact that each staff member and manager sees risk through the lens of their own performance measures, it might be necessary to re-invest in some people or a department, which has an overall view of internal and/or external risks in the company supply chain. It might be a quality manager or a quality department.

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