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HOW TO ACHIEVE AND SUSTAIN OPERATIONAL EXCELLENCE BY IMPLEMENTING SIX SIGMA BREAKTHROUGH METHODOLOGY

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ABSTRACT

In today’s ultra competitive business environment, product life cycles have become shorter. Freeing markets and globalization have increased competition. The reliability, timeliness, accuracy, and perceived value of the products or services have become the keys to company success. The business environment has become turbulent, complex, and even chaotic. To maintain and extend competitive advantages in all dimensions and markets, companies shift increasingly from defining quality as a task that can be run by a quality department, to seeing it as the overall long-term umbrella objective of their business.

In this era, all manufacturing concerns across the globe are facing new challenges of competitiveness in the emerging markets and struggling hard to improve their financial performances by deploying new quality improvement initiatives. New methods to improve process capabilities and effectiveness are emerging and being applied. This seems to become increasingly important in operational level processes. In their quest to enhance operational level efficiency, market leaders in any segment of business continue to search for the latest quality tools and techniques which can enable them to improve their bottom lines and help them to stay ahead with their global competitors. Undoubtedly, Six Sigma breakthrough methodology coupled with lean practices has had helped world’s leading corporations to achieve their aggressive objectives.

This paper will address not only basic concepts of Six Sigma but also how this emerging breakthrough methodology has revolutionized the world’s leading multinational companies. Subsequently, critical factors to ensure successful implementation of Six Sigma and the key barriers, issues and implementation concerns that lead companies to gain no benefit of its deployment will also be addressed. Further, key imperatives that can ensure successful deployment
within a SME context will also be part of this endeavor.

Key Words: Cost Of Poor Quality (COPQ), Time To Market (TTM), Key Process Input variable (KPIV), Overall Equipment Effectiveness (OEE)

INTRODUCTION

Motorola is the originator of Six Sigma. Motorola learned about this quality concept the hard way after being consistently beaten in the competitive marketplace by foreign firms that were able to produce higher quality products at a lower cost. When a Japanese firm took over a Motorola factory that manufactured Quasar television sets in the United States in the 1970s, they promptly set about making drastic changes in the way the factory operated. Under Japanese management, the factory was soon producing TV sets with \( \frac{1}{20} \) th the number of defects they had produced under Motorola management. They did this using the same workforce, technology, and designs, making it clear that the problem was Motorola’s management.

Finally, in the mid 1980s, Motorola decided to take quality seriously. Motorola’s CEO at the time, Bob Galvin, started the company on the quality path known as Six sigma and became a business icon largely as a result of what he accomplished in quality at Motorola.

HIDDEN FACTORY WITHIN A FACTORY

Companies, especially manufacturing concerns, face tremendous pressures from Cost of Poor Quality (COPQ). Hidden factories within in the manufacturing environment lead them to lose their potential improvement opportunities.

In other words, cost of poor quality means loss of profit opportunity for a company. If company can manage to reduce COPQ, it can sustain or even grow profit margins over its competitors, and also lead in the Time To Market for its products and services.
Further to understand COPQ impact to non-Six Sigma companies, companies operating at three or four sigma typically spend between 25 and 40 percent of their revenues fixing problems. This is known as the cost of quality, or more accurately the cost of poor quality. Companies operating at Six sigma typically spend less than 5 percent of their revenues fixing problems (Figure 1). The dollar cost of this gap can be huge. General Electric estimates that the gap between three or four sigma and Six Sigma was costing them between $8 billion and $12 billion per year.
Six Sigma is not a theory of management, or even a single business methodology. It is a comprehensive system for improving business leadership and performance. Six Sigma provides tools to systematically improve your entire business. These tools work as well in upgrading your internal service departments as they do in streamlining manufacturing operations.

Sigma is a Greek alphabet character used by statisticians to measure the variability in any process. A company’s performance is measured by the sigma level of their business processes. Traditionally companies accepted 3 or 4 sigma performance levels as the norm, despite the fact that these processes create between 6,200 and 67,000 problems per million opportunities! The Six Sigma standard of 3.4 problems per million opportunities in long term is a response to the increasing expectations of customers and the increased complexity of modern products and processes. Fig. 4 illustrates a Six Sigma mean centered process.

Six Sigma has a simple performance improvement model called Define-Measure-Analyze-Improve-Control “DMAIC” model. By using proven tools and techniques within the simple framework of this performance improvement model, practitioners can improve their bottom lines drastically.

Six Sigma makes breakthrough improvements by using quantitative analysis to further narrow down the KPIS using soft tools such as:
- Correlation
- Multi-variance study
- ANOVA & Hypothesis Testing

The statistical methods employed in Six Sigma differ substantially from those taught in engineering or statistics programs. Six Sigma emphasizes observational methods and experimentation in the scientific context, for example, two-level factorial experiments are standard, and graphical methods are emphasized for the analysis of these experiments. Experimentation is not simply analysis of variance. While the latter facilitates understanding of experimental results for statisticians, for engineers it can be an impediment to planning and carrying out experiments.

Six Sigma is a disciplined, focused and systematic approach to variance reduction; applicable throughout the value chain - from product design to customer application. This methodology stresses to optimize your current processes and reduce variation to the minimal level.

Figure 4: A Six Sigma process

Figure 5: DMAIC Improvement Model
Traditional quality improvement approaches are incremental and need long lead times to get benefit of these improvements. Contrary to this, Six Sigma approach demands substantial improvements in your business processes and services in a short period of time and dictates how to sustain them as well. Below figure gives a clear understanding of this philosophy.

![Six Sigma process optimization approach](image)

**Figure 6: Six Sigma process optimization approach**

The most powerful feature of Six Sigma is not only to provide complete systematic approach to reduce variability from your processes but also creation of an infrastructure to ensure that performance improvement activities have the necessary resources. Some study’s shows that, failure to provide this infrastructure is the #1 reason why 80% of all TQM implementations failed in the past. Six Sigma makes improvement and change the full-time job of a small but critical percentage of the organization's personnel.

![Six Sigma enables breakthrough level improvement](image)

**Figure 7: Six Sigma enables breakthrough level improvement**
Figure 8: Six Sigma infrastructure in Large Corporations

MBB, BB and GB’s are the full time change agents and play a catalyst role to institutionalize the change. Figure 8 illustrates the required human resource commitment to achieve a successful cultural change in an organization.

Seagate is an established world leader of hard disc design, manufacturing and distribution around the world. Operating under the strict quality and cost restrictions as required to be a market leader, Seagate constantly endeavors to keep high levels of OEE as well as Six Sigma quality standards.

In order to maintain its market leadership, Seagate started Sigma Six in late 1990’s and saved millions of dollars from successful implementation of Six Sigma throughout its global business. Seagate has trained all levels of employees and has even introduced Six Sigma white belt to its shop floor work force.

Hundreds of Lean and Six Sigma projects have been completed at Seagate. Those have contributed not only to improve financial performance by minimizing the defects in its products and processes but also have substantially reduced its delivery lead times to customers. Numerous projects are also underway that illustrate the leverage and power of the combined Lean-Six Sigma approach at Seagate.

By integrating Lean and Six Sigma skill sets into its operations, Seagate was able to achieve a challenging target to reduce its shipment lead times to customer. In one example, Seagate Customer asked Seagate to ship hard drives on a tight schedule in order to test and approve them for volume shipment. To fulfill a valuable customer’s demand, Seagate had to beat the deadline by three days. Four days versus seven days was a major improvement challenge for Seagate.

The logistics group was charged with improving the finished goods on-time shipment rate from Asia factories to warehouses where products await customer orders. It used to take a week to ship product to a customer anywhere in the (developed) world; the project goal was to reduce that schedule to four days.

The project was challenging, given the complexity of Seagate’s global business. For example, Seagate works with dozens of ports, each with its own freight-handling agent and numerous freight carriers. Shipments can go to up to 100 “hubs,” all managed by various companies, all of whom could independently subcontract with yet more shipping companies.

A Black Belt project under the leadership of a senior manager of customer service in Scott’s Valley USA indicated that the variability of performance by each of these multiple "moving parts" was keeping Seagate from reducing its global delivery time from seven days -- a classic Six Sigma diagnosis. Digging into the underlying problems revealed that various ports and freight handlers had widely varying processes that made the flow of goods through the system inefficient--a classic Lean challenge.

The team applied Six Sigma, Lean and Theory of Constraints tools and eventually met their four-day global shipping target. Seagate also trained its third-party logistics partners in Lean and Six Sigma techniques. Plus, the Seagate logistics traffic team was trained at the Green Belt level, meaning everyone could collaborate around the same toolset and language, and work the problem in the same direction.

Today, four days is the global shipping standard 87 percent of the time, allowing
Seagate to reduce the number of days of inventory in warehouses. That means a big cost savings for the company.

Another improvement case from Seagate’s manufacturing process at Thailand Operations that saved nearly 200,000 US$ / year and reduced 86% consumption of a chemical being used for in-line product cleaning process. A black belt project was initiated to discover all KPIV’s through the DMAIC improvement model and used data mining techniques to narrow down the potential KPIV’s and finally discovered that only 2 major process inputs (chemical leakage and high level of chemical in the boil tank) have substantial impact to higher consumption of the chemical. After fixing all leakage points in the tank and implementing new upper control limits for chemical top up in the boiling tank enabled project owner to achieve the desired goal of 86% reduction of chemical in the cleaning process.

Another improvement case study deals with packaging process. It was discovered that packaging-processing time per box was too high (nearly 2.5 minutes) along with high cost of packing operators, i.e. more than 130,000 US$ per year. The target of this improvement project was 20% reduction of packing process time / box along with improving headcount utilization for the packing process. After a deep analysis using Six Sigma and lean tools and techniques, it was discovered that there are two major KPIV’s (location of packing is too far from store and no roller facility available at the unload area of sealing machine) and these conditions must be improved to yield the desired results. Action was executed as per recommendations from the project owner that has reduced not only the cycle time of packing per box 20% but also improved the operator utilization (25% head count reduction).

Similar to above improvement cases, Seagate professionals and manufacturing workers have completed several engineering and transactional projects in all Seagate operations across the globe and enabled company to create a world class manufacturing process.

Not only limited to DMAIC approach to improve existing processes, Seagate also has taken a proactive initiative to implement Design For Six Sigma (DFSS) methodology to design and develop its new disc drives. This approach has resulted in a great success and paved the way for adoption of DFSS approach into its new tooling and equipment design and development process as well.

**IMPLEMENTATION OF SIX SIGMA**

Successful implementation and execution of Six Sigma methodology is indeed a big challenge for those who want to embrace it. It demands tremendous discipline and rigor to implement. It requires the resources of a mature and capable organization. Many companies are intrigued by the promises of Six Sigma, and many have tried to achieve it. But unless the organization fully embraces Six Sigma, and commits to the likelihood of a radical shift in its business processes, Six Sigma can easily go the way of past quality methodologies.

Remember quality circles, Total Quality Management (TQM), Continuous Process Improvement (CPI), and other quality programs of the 80’s? These programs often failed to meet expectations—largely because their results rarely justified the effort and because the discipline required to implement them was simply too great. Most failed Six Sigma programs today suffer from these same challenges.

To ensure successful launch of a Six Sigma program, organizations need to embrace Six Sigma as a new way to look at their business processes. They need to approach this as a sustained, long-term change to their business, as opposed to a quarterly quick fix. Six Sigma takes years, not months, to implement successfully. It is a lasting organizational change. Any company that applies Six Sigma as a
band-aid will get little or no benefit. The changes must be fundamental to the business, organization-wide and persistent.

Organizations should also tailor their Six Sigma program, with the help of specialists, to meet their particular needs. Some organizations may wish to integrate proven best practices of Lean principles as well. However, the training materials should not be simply a collection of defunct programs.

HOW TO LAUNCH SUCCESSFUL IMPLEMENTATION

Several research studies conclude that management’s role in the field of quality management is crucial. In the organizational change, process managers are the agents that initially direct developmental actions. It is believed that management should take the initiative in seeking and adopting new ideas, philosophies, and models. The deep commitment of top management is the initial factor that makes the implementation process real and eventually successful. A successful strategy demands as follows:

1. Strategy and goals of improvement efforts need to be clearly defined.
2. The right projects and people should be selected.
3. The direction, potential benefits, and results of improvement activities need to be communicated to all involved to ensure commitment.
4. The resources, that is, people, time, and money, need to be clearly allocated.
5. Finally, desired improvement alternatives and desired behaviors need to be recognized and reinforced. This includes periodic project reviews between management and the people responsible for improvement activities.

In addition to above, coaching, counseling and training of people plays a crucial role as well.

Further, Six Sigma leadership incorporates six crucial principles in the successful implementation of this methodology as follows:

- The first principle is genuine customer focus. Improvements are based on the degree of the impact on customer satisfaction and value.
- The second principle is data- and fact driven management. The disciplined approach of Six Sigma begins with clarifying what measures are really needed as keys to monitoring business performance.
- The third principle is process focus, the management of the process, and process improvements. Controlling both service and manufacturing processes may result in increased customer value.
- The fourth principle is proactive management. Six Sigma tools and practices support a dynamic, responsive, and proactive style of management.
- The fifth principle is boundary free collaboration. Teamwork facilitates the achievement of common goals and it provides value to the customer.
- Finally, the last principle is striving for perfection but tolerating failures.

Any organization that pursues the Six Sigma level of quality, due to changes in customer requirements, has to increase performance to the highest (perfection) level, on the one hand, while being prepared to manage occasional setbacks, on the other.
KEY STEPS TO MAKE A MOVE

Executive management team must have total commitment to implementation of Six Sigma methodology and must accomplish the following first:

- Establish a Six Sigma Leadership Team.
- Identify key business issues.
- Assign Masters to each key business issue.
- Assist the Masters and Leadership Team in identifying critical projects that are tied to the key business issues.
- Assist the Masters and Leadership Team in selecting Expert candidates.
- Allocate time for change agents (Experts) to make breakthrough improvements.
- Set aggressive Six Sigma goals.
- Incorporate Six Sigma performance into the reward system.
- Direct finance to validate all Six Sigma ROI.
- Evaluate the corporate culture to determine if intellectual capital is being infused into the company.
- Continuously evaluate the Six Sigma implementation and deployment process and make changes if necessary.

Price Waterhouse Cooper described following key factors that helped the most successful companies to achieve their business improvement goals:

- Good communication 100%
- Strong mandate by senior management 95
- Setting up intermediate goals and deadlines 95
- Having an adaptive plan 91
- Having access to adequate resources 86
- Demonstrating urgency of change 86
- Setting up performance measures 81
- Delivering early, tangible results (“quick wins”) 76
- Involving customers and suppliers early 62
- Benchmarking performance vs. competitors 62

Six Sigma approach is simple, but not easy to deploy. If organizations get success to implement it, the results will justify the effort expended.

COMMON BARRIERS AND HURDLES

Why does Six Sigma or Lean Six Sigma fail to achieve desired results for some organizations? One major reason is resistance to change and a lack of commitment from top management team to Six Sigma activities. But this is the fact that who embraces change quickly and make a solid commitment can cross the barrier to be market leader in this ever-changing era. Like any other major change program, below are top ten barriers for a successful deployment of Six Sigma.

- Competing resources 48%
- Functional boundaries 44
- (Lack of) change skills 42
- Middle management 38
- Long IT lead times 35
- Communication 34
- Employee opposition (resistance) 33
- Initiative fatigue 32
- Unrealistic timetables 31

One of the major barriers, as noted above is the competing resources. The start-
up cost for institutionalizing Six Sigma into a corporate culture is an expensive investment. This discourages many SMEs from deploying of Six Sigma methodology into their businesses.

**SME'S BUSINESS IMPROVEMENT**

Having arisen in large corporations and became known and applauded on Wall Street, Six Sigma has set a new paradigm of excellence in the manufacturing world of big corporations, but it appears that the majority of small and medium sized enterprises (SMEs) either do not know the Six Sigma approach, or find it unsuitable to meet their specific requirements.

In today’s highly competitive environment, it is also becoming increasingly important for SMEs to initiate such a quality endeavor (e.g. Six Sigma and Lean) to improve their bottom lines and struggle hard to stay ahead with their global competitors.

Before beginning any lean and Six Sigma deployment, it is imperative to understand unique SMEs circumstances and requirements. Unlike large organizations, SMEs generally have effective and open communication channels, low resistance to change, people orientation, employees employing a natural responsibility for quality, company-wide awareness, functional integration, and innovativeness, and other fundamental advantages for SMEs over large corporations. However, SMEs face disadvantages in the continuous search for the improvement of the business with quality, productivity and cost reductions as indivisible elements, as well as process orientation, spending on training, and discipline about goals and standards.

There are several factors those need to be represented in a Six Sigma initiative within an SME context, including:

- Every single project has to contribute positively and directly to the company’s bottom line, calculated through full costing. In fact, this requirement reflects the most substantial difference to Six Sigma programs in large corporations, as these usually calculate net-benefits from Six Sigma projects by subtracting the costs, which directly evolve through a project from its financial benefits.
- Large corporations routinely track project results for 12 months - this should be maintained in an SME environment. An exclusive focus on core processes and an adjustment in the project tracking methodology should reduce the amount of effort required for the tracking.
- A training program has to be employed which is significantly shorter than in large corporations, but is still based in the well-proven methods and tools of QM adjusted to specific SME needs.

- SMEs should carry out a one-day awareness raising program to facilitate the cultural implementation element of a Six Sigma program and to encourage active support of, and participation in, organizational improvement.
- The Six Sigma roles should be restricted to the project leaders in the SME organization (e.g. an “SME black belt”). The rest of the workforce and management staff should only participate in the awareness training.
- SMEs require consulting services that differ significantly from those usually found in the marketplace aimed at larger corporations. According to market research, SMEs require consultants and trainers offering modular services, which allow the addition or subtraction of elements without compromising the entirety of the concept and without risking the
success for their target group.

The above mentioned factors are few of many factors that need to be taken into account before tailoring any Lean Six Sigma Initiative in any SME’s environment.

CONCLUSION

Six Sigma has permeated today’s business life and emerged as a breakthrough improvement strategy. It has set a new paradigm of excellence in large multinational companies. Although Six Sigma has strong advocates and success stories in the manufacturing world of big corporations for its ability to help factories get lean, in the context of SMEs’ business, management should understand first how to develop a customized Six Sigma approach that can address SME’s specific business requirements and can lead them to improve their bottom lines faster.

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