Implementing Lean Six Sigma

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Abstract—Fulfilling the sharply increasing demands of customers for quality items needs increased speed, high quality output of products and services, improved responsiveness and flexibility to customer requests. All these and other requirements can be met with by reducing non-value adding activities, eliminating wasted time, materials and expenses, reducing cycle time, reducing variation and defects. Implementing Lean Six Sigma makes this possible.

This paper gives a broad view of the essential steps in implementing Lean Six Sigma mentioning some very important aspects which add non value added activities.

Keywords—Continuous flow, Lean, Lean Six Sigma, Six Sigma,

I. INTRODUCTION

There is a continuous increase in customer’s awareness for quality and demands for quality items. Moreover this increase is usually quite sharp. The costs of quality on the other hand have become very high. In fact for many companies, these costs may be too high to survive and improve their competitive position. The solution is to develop culture to continuously adopt evolving techniques in quality line and make their activities customer focused.

‘Six Sigma’ is a management innovation methodology to produce virtually all products or services that are defect free based on the process data by improving business processes and thereby satisfying customer and employee and reducing costs.

Lean strategies link the value added steps to optimize process flow by the elimination of the non- required steps. Lean can help in locating the processes with highest impact opportunities for Six Sigma. And every process improvement will simultaneously make the optimum flow possible easily and at lower cost.

Preparing integrated macro and micro process maps, doing value analysis, assessment of layouts and work cell designs, continuous flow, scheduling for pull, Kanban, load balancing, improving throughput rate, incorporating Six Sigma: Define, Measure, Analyze, Improve, Control (DMAIC); for each critical sub activity to improve performance are the important steps in implementing Lean Six Sigma. Most importantly all these should be based on continuous feeding of customer’s requirements.

Here we review both Six Sigma and Lean strategies, in brief; discuss the effect of integrating them, and implementing Lean Six Sigma so that the ever changing demands of customers are fulfilled.

The future prospects and concluding remarks, if given due importance; can help make all the individuals get at least the basic requirements at affordable costs.

II. ‘SIX SIGMA’

The credit of coining the term Six Sigma goes to Bill Smith, a Motorola engineer. In the early and mid 1980s, with Chairman Bob Galvin at the helm; engineers decided that the traditional quality levels-measuring defects in thousands of opportunities- didn’t provide enough granularities. Instead they wanted to measure the defects per million opportunities. Motorola developed this new standard and needed cultural change associated with it [1]. Motorola invented Six Sigma and they have learned a great deal about it since 1986 [2].

But the roots of Six Sigma, as a measurement standard; can be traced back to Carl Fredrick Gauss (1777-1885) who introduced the concept of the normal curve. Six Sigma as a measurement standard in product variation can be traced back to the 1920s when Walter Shewhart showed that three sigma from the mean is the point where a process requires correction. Many measurement standards came on the scene later on.

In short ‘Six Sigma’ is several things.

• A statistical basis of measurement: 3.4 Defects Per Million Opportunities (DPMO),
• A philosophy and a goal: as perfect as practically possible,
• A methodology,
• A symbol of quality,
• A vision,
• A metric [3] [4].

All ‘Six Sigma’ is an approach, which will improve business processes, thereby increasing customer and employee satisfaction and reducing costs [5]. ‘Six Sigma’ is an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods the scientific method to make dramatic reduction in customer defined defect rates [1]. This definition highlights the importance of improvements based on the customer’s definition of a defect in terms of their “critical to quality” parameters. ‘Six Sigma’ advocates establishing goals based on customer requirements not on internal considerations. The results of Quality Function Deployment (QFD) can be used to prioritize the most important system design elements, enabling efforts and
resources to be concentrated on improving those that most effectively meet customers’ needs [6] [7]. Pacific Bell’s Quality Improvement Program regarding customer contact can be employed to know about customers’ needs. [8].

III. THE LEAN MANUFACTURING PHILOSOPHY

Lean Manufacturing was born in 1914 with Henry Ford and the mass production moving assembly line [9]. Though it was missing some of the most important and common factors in today’s lean philosophy.

Lean Manufacturing is a philosophical way of thinking. Lean Manufacturing can be defined as: “A systematic approach to identifying and eliminating waste (non-value-added activities) through continuous improvement by making the product flow at the pull of the customer in pursuit of perfection” [10]. Lean does not simply work by employing one or even a couple elements of the lean philosophy. “It is a philosophy of manufacturing that seeks to minimize unnecessary time, materials, and effort in the production process” [11]. Perhaps a more understandable definition as defined by John Shook is: “A manufacturing philosophy that shortens the time line between the customer order and the shipment by eliminating waste” [12]. “This does not mean that you keep a large supply of inventory in a warehouse and ship immediately when the customer orders. It means that you build what the customer orders as soon as possible after the order and that the total lead time is as short as possible. Any time a product is sitting, just waiting in a queue somewhere, is waste” [12].

Lean Manufacturing mainly aims at eliminating or at least minimizing waste. A lean system however, can not be achieved by quick fixes or long solutions. Lean Manufacturing also strives to streamline the flow of production material throughout the factory [11]. Besides eliminating waste, lean wants to eliminate variability. (“The variability to which we are referring is the variability in processing time.”)[11]. Even more importantly than reducing variability in processing time is reducing cycle time and the variability in cycle time. Reducing cycle time is a core objective of lean manufacturing. Variability is anything that disrupts the flow of this so-called production stream. Some of the reasons that variability occurs in a production operation are:

- Unreliable equipment
- Lack of standardized procedures
- Uncontrolled environmental conditions
- Long setup operations
- Large production lots
- Late deliveries from suppliers
- Inappropriate management decisions [11].

Lean is not a final goal that a company works towards. It is an ever-changing way of thinking to make the company the best it can be at all times. Simply put, lean manufacturing is making the customer happy by getting them their product in the fastest way possible with the highest quality possible while making the largest profit possible.

IV. ‘SIX SIGMA’ VERSUS LEAN

Black and Decker have attempted to bring the two together under a ‘Lean Sigma’ banner. *Six Sigma and Lean are not always complementary e.g. if an organization is in risk of receivership due to falling customer sales as a result of poor quality, beginning with a 5S exercise may not be appropriate.* Also lean does not have such a robust structure to mirror Black Belts.*Nor does Lean have a focus on driving direct costs out of an organization.* Lean improvements such as space utilization are of benefit but this is difficult to transpose onto the profit statement.* Lean approach is a valuable one, but to call Six Sigma “Lean with stats” is misinformed [13].

V. LEAN SIX SIGMA

Many organizations are not seeing the best possible returns from their Six Sigma programs. According to the Aberdeen Group in 2006, “Industry is missing out on billions of dollars in potential savings, sales, and profits each year through ineffective application of Six Sigma tools and methodologies.”

Practitioners have identified lack of leadership support, narrow focus on cost reduction, lack of management oversight, and incomplete understanding of customer needs as factors that limit the effectiveness of Six Sigma programs. However, there is one key factor that has not received enough attention. And that is the way Six Sigma programs are currently implemented in most organizations makes it nearly impossible for management to monitor the effectiveness of the program, let alone continually improve by taking advantage of the organizational learning and experience gained over time.

Despite Six Sigma’s incredible success at improving process efficiency & customer satisfaction, by itself Six Sigma is not enough. The Kano model of customer satisfaction shows why. This model shows that there are three categories of quality items which effect customer satisfaction: dissatisfiers, satisfiers and “delighters.” Six Sigma addresses customer satisfiers and dissatisfiers, things the customer will notice if not done right. But delighting customers requires innovations that customers have not even conceived. Developing an organization with the ability to consistently produce exciting new products and services requires going beyond Six Sigma. It requires “Spontaneous Enterprise” [14].

Galvin has discussed eight dimensions of quality. In this context it is necessary to think of complete product life cycle. Hence in addition to wastes identified under the banner of Lean Manufacturing, wastes due to rework, lost reputation, lost time in handling complaints etc. resulting because of using wrong specification-product for appliance which results in poor performance and shorter life is found to be quite large and neglected. Loss due to lack of availability of proper and timely after sales service and spares is another
measure. The Lean Six Sigma implementation methodology suggested here will take care of these and such many issues along with the intended ones.

To make Six Sigma enable address delighting customers, along with addressing customer dissatisfiers and satisfiers it is necessary to integrate it with Lean strategies. Lean Six Sigma enables gaining speed, efficiency and flexibility for maximum performance and helps

- Reduce non-value added activities
- Eliminate wasted time, materials and expenses
- Increase speed, output of products and services
- Improve responsiveness and flexibility to customer requests
- Integrate lean activities with Six Sigma and other performance improvement methods
- Focus your Six Sigma improvement activities in operational areas that impede process flow because of un-controlled variation
- Improve performance [13] [15].

VI. IMPLEMENTING LEAN SIX SIGMA

Submission All experts and practitioners have come to a conclusion that customer satisfaction is the most important goal for any firm. All other goals like setting reputation, market share growth, employee and firm growth, and sustainability are automatically reached. And we all know that customer demands of quality and variety are changing at a very fast rate. Fulfilling the sharply increasing demands of customers for quality items needs increased speed, high quality output of products and services, improved responsiveness and flexibility to customer requests. All these and other requirements can be met with by reducing non-value adding activities, eliminating wasted time, materials and expenses, reducing cycle time, reducing variation and defects. Implementing Lean Six Sigma makes this possible.

Knowledge Management can help Six Sigma and Lean by feeding with customer requirements and expectations in advance and faster [16]. This can be used to define ‘defects’ and ‘critical to quality’ for Six Sigma and doing value analysis in case of Lean. Sometimes the complete product becomes without value because of the changes in the market, or due to a highly competitive product being launched. If Knowledge Management is effective, such situations can be handled more effectively incorporating the required changes in the design of product. National Semiconductors, an excellent example, closed down its division Cyrix Corporation, the well-known manufacturer of low-end Intel-clone microprocessors in 1999 when it realized that it was pulling the entire company down as it tried to withstand piece-based assaults from mighty Intel, which had pockets than those of National. Many times customer requires a few changes to be made in the product. KM helps in deciding which activities are value adding and which are non-value adding, related to the required changes in case of Lean and deciding ‘critical to quality’ for Six Sigma.

Knowledge Management (KM) helps in doing value analysis for Lean, as already mentioned, and further for selecting Six Sigma projects. KM experts have identified twenty-four key drivers several, if not all; will probably apply to any business, irrespective of the type of industry. Especially knowledge-centric drivers, because training at all levels is one of the most important success factors of Six Sigma and Lean both. Technology drivers of KM are very much essential for compression of product and process cycles. Doing KM also augments connecting Lean and Six Sigma to business strategy, suppliers, and information technology. Microsoft, eBay, eFax, CISCO, and Pfizer are a few of several hundred thousand examples of success stories of KM. Hence making use of the well managed knowledge, decision making in Lean and Six Sigma will be faster and more effective for achieving customer satisfaction. Also both Six Sigma and Lean are strongly related to cultural change that is positively made with the help of KM.

A. Phase 1 Initialize

Phase 1.1 Understanding the Lean Six Sigma philosophy

The management must clearly understand the meaning of Lean Six Sigma, the opportunities, the dangers, the level of commitment required, the management support required for the implementation, the management and culture change that needs to take place, funds required, and the benefits of implementing Lean SIX Sigma.

This first step needs to take senior members and key decision makers through the above issues in some detail so that they gain a good understanding of how to create Lean Six Sigma. The purpose of this first step is to a) decide whether Lean Six Sigma is an approach that can be supported by them and the business, b) to define a vision of Lean Six Sigma for the business, c) to create an implementation plan, d) to decide on the key sponsor, e) to ensure that Lean Six Sigma will deliver the businesses strategic objectives, f) to fully understand the management and culture change that needs to take place in order to deliver a truly Lean Six Sigma business, g) to assign a budget and analyze the benefits and h) to create a top level value stream map of the business.

Phase 1.2 Prioritization

Prioritize the implementation, which is of major importance as it is often assumed that the biggest area for improvement is in the manufacturing /processing areas. Actually, the opposite can be true as most businesses have been focused on manufacturing for some years and may well find to improve support parts of the process actually unlock more potential in manufacturing as a result. Clearly, the vision and plans then need to be communicated to the workforce.

B. Phase 2 Visualization

Phase 2.1 Macro process map and value analysis

Divide the complete industry or concern into measure functional processing centers and prepare the process map. Do value analysis for each measure functional processing center. What is the value added by the center? How can value added
be improved? Answers to such questions for each center are to be found out. The concepts of transfer prices and average market prices can be used as the reference.

**Phase 2.2 Micro process map and value analysis**

Split the measure centers’ into sequential elements. Do value analysis for each activity in the element. What is the value added by the center? How can value added be improved? Can some of these activities or whole element be eliminated without reducing the value added by the center?

**Phase 2.3 Value Stream mapping**

Value Stream Mapping is a tool used to create a material and information flow map of a product or processes. It enables companies to map the flow of products right from raw material, through all manufacturing process steps, to the finished product stage.

2.3.1 The current state map - it shows you where you are.

2.3.2 The future state map - it shows you where you’re going and how you're going to get there. (Or it shows the plan of your lean journey).

Using the Value Stream Map, you can streamline work processes, which results in cutting lead times and reducing operating costs.

**C. Phase 3 Design**

Design the Process Management System including facility layout and allocation design focusing at assessment of layouts and work cell designs, continuous flow, scheduling for pull, Kanban, and load balancing.

Designing the Process Management System involves five activities working in concert.

- **Documentation**: Document key processes.
- **Organization**: Define and create organizational roles.
- **Technology**: Learn and implement enabling technologies.
- **Requirements**: Analyze and establish performance requirements.
- **Measurements**: Identify the need and develop measurement system.

**D. Phase 4 Operate.**

Operate and use the system to analyze process performance. Operating the Process Management System examines how to use the system to monitor and analyze your processes using dashboards and process analysis tools while identifying critical areas that are candidates for improvement.

**E. Phase 5 Improve**

Improve the processes where necessary using Lean, DMAIC, and Define, Measure, Analyze, Design, Verify (DMADV) methods.

**F. Phase 6 Establish**

Establish knowledge supply chain production department-sales department-dealers-sub dealers-retailers-customer. This makes it possible to put the product / service for the designed purpose or use leading to the best performance.

This allows the product perform efficiently saving amount of non value adding (negative value adding) communication, rework, scrap work, loss of reputation and goodwill etc. caused due to use of a product/service for unintended, improper use where it does not perform as per design and expectation.

Also establish information supply chain in the reverse order which will help fulfill requirement of continuous adaptability to ever changing demands and tastes of customers with required speed and quality.

**G. Phase 7 Sustain**

Sustain process improvements with effective communication tools. Replication, Standardization, and Communication are the basic elements of sustainability.

**H. Phase 8 Adopt**

Adopt the process through the usage of change management techniques.

**VII. CONCLUSION**

Implementing ‘Lean Six Sigma’ using the above methodology would combine benefits of Lean and Sigma. This will enable a concern establish and enhance information integration, performance management, sequential processing, point of use logistics, cycle time management, process linearity, resource planning, customer connectivity.

All this will result in achieving increased speed, improved quality and reduced costs. In turn optimized business results and goals would be achieved. This is a way to exceeding bottom-line and customer expectations and will delight the customer.

As a future scope Lean Six Sigma needs to be further studied from a combined perspective of knowledge management and theory of constraints in order to further enhancement of its effectiveness.

Let us all start working towards this direction with a view to achieve right quantity and quality of goods and services at right time by minimizing wastages utilizing minimum energy and resources so that every individual in the world gets at least minimum required healthy living standard.

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