

GAINING A COMPETITIVE ADVANTAGE WITH LEAN SIX SIGMA PHILOSOPHIES AND TOOLS

Flt Lt Dinesh Kumar Gupta (Retd.)

Associate Professor, Department of Mechanical Engineering, Global Institute of Technology and Management, Gurgaon, Haryana, India

ABSTRACT

Lately there's been a great deal of talk around Lean execution. But, some people speak of Lean, some speak of Six Sigma and some use a combination of the two. But, what's the difference? How do you know what's right for your organization? This study report presents the comparative study between Lean versus Six Sigma or combination of both. As the market place tightens and companies are fighting for every dollar of revenue, they need to adopt innovative methods to create more efficient processes that will give them a competitive edge of their closest rivals; this is the basis for Lean Six Sigma. Unlike traditional Six Sigma, Lean Six Sigma uses some of the methodology from lean manufacturing along with the Six Sigma approach. Many organizations see Lean Six Sigma as the evolution of the Six Sigma methodology rather than a modification. Lean Six Sigma takes the fundamentals of Six Sigma and incorporates the cost reduction principles of Lean Manufacturing.

Key words: *Cost reduction; efficient processes; Lean manufacturing; Lean Six Sigma*

1. HISTORY

Six Sigma is a set of tools and techniques/strategies for process improvement originally developed by Motorola in 1981 Six Sigma became well known after Jack Welch made it a central focus of his business strategy at General Electric in 1995, and today it is used in different sectors of industry[1]. Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing variability in manufacturing and business processes. It uses a set of quality management methods, including statistical methods, and creates a special infrastructure of people within the organization who are experts in the methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has quantified value targets, for example; process cycle time reduction, customer satisfaction, reduction in pollution, cost reduction and/or profit increase

The term *Six Sigma* originated from terminology associated with **manufacturing**, specifically terms associated with statistical modeling of manufacturing processes. The maturity of a manufacturing process can be described by a *sigma* rating indicating its yield or the percentage of defect-free products it creates. A six sigma process is one in which 99.99966% of the products manufactured are statistically expected to be free of defects (3.4 defects per million) as shown in fig.1, although, this defect level corresponds to only a 4.5 sigma level. Motorola set a goal of "six sigma" for all of its manufacturing operations, and this goal became a byword for the management and engineering practices used to achieve it.

Like its predecessors, Six Sigma doctrine asserts that:

- Continuous efforts to achieve stable and predictable process results (i.e., reduce process variation) are of vital importance to business success.
- Manufacturing and business processes have characteristics that can be measured, analyzed, controlled and improved.

- Achieving sustained quality improvement requires commitment from the entire organization, particularly from top-level management.

Features that set Six Sigma apart from previous quality improvement initiatives include:

- A clear focus on achieving measurable and quantifiable financial returns from any Six Sigma project.
- An increased emphasis on strong and passionate management leadership and support
- A clear commitment to making decisions on the basis of verifiable data and statistical methods, rather than assumptions and guesswork.
- A special infrastructure of "Champions", "Master Black Belts", "Black Belts", "Green Belts", etc. to lead and implement the Six Sigma approach [2].

The term "Six Sigma" comes from a field of statistics known as process capability studies. Originally, it referred to the ability of manufacturing processes to produce a very high proportion of output within specification. Processes that operate with "six sigma quality" over the short term are assumed to produce long-term defect levels below 3.4 defects per million opportunities (DPMO) as shown in fig 1. Six Sigma's implicit goal is to improve all processes, but not to the 3.4 DPMO level necessarily. Organizations need to determine an appropriate sigma level for each of their most important processes and strive to achieve these. As a result of this goal, it is incumbent on management of the organization to prioritize areas of improvement.

Six Sigma is a registered service mark and trademark of Motorola Inc. As of 2006 Motorola reported over US\$17 billion in savings from Six Sigma. Other early adopters of Six Sigma who achieved well-publicized success include Honeywell (previously known as AlliedSignal) and General Electric, where Jack Welch introduced the method. By the late 1990s, about two-thirds of the Fortune 500 organizations had begun Six Sigma initiatives with the aim of reducing costs and improving quality. In recent years, some practitioners have combined Six Sigma ideas with lean manufacturing to create a methodology named Lean Six Sigma. The Lean Six Sigma methodology views lean manufacturing, which addresses process flow and waste issues, and Six Sigma, with its focus on variation and design, as complementary disciplines aimed at promoting "business and operational excellence". Companies such as GE, GENPACT, IBM and Sandia National Laboratories use Lean Six Sigma to focus transformation efforts not just on efficiency but also on growth. It serves as a foundation for innovation throughout the organization, from manufacturing and software development to sales and service delivery functions.

The International Organization for Standards (ISO) has published ISO 13053:2011 defining the six sigma process.

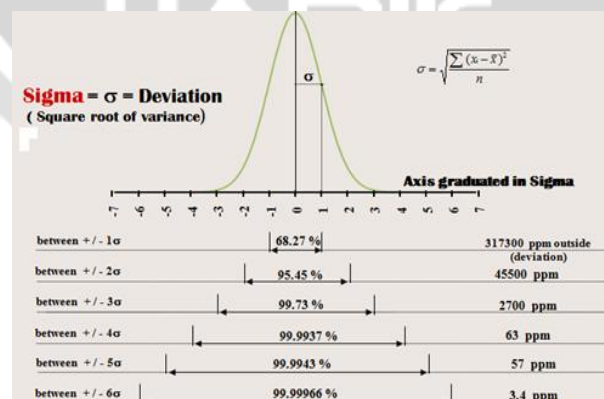


Fig 1 Concept of Six Sigma

2. INTRODUCTION

What is Lean Six Sigma(LSS)? How will it benefit me /us? What type of issues does it solve? How do I implement it in my business? How do I choose a supplier of training and consultancy? What do all these terms mean? These are the FAQ's about the LSS that have been examined and answered in this study report. Six Sigma has been developed over the last thirty years and has become the de facto methodology to eliminate defects from a process and improve the quality of the manufacturing process. The objective of the methodology

is the implementation of a measurement-based strategy that focuses on process improvement and variation reduction. Six Sigma is a business management strategy that was initially developed by Motorola in the 1980's, which is used by many Fortune 500 companies. It is used primarily to identify and rectify errors and defect in a manufacturing or business process. The six sigma system uses a number of quality methods and tools that are used by Six Sigma trained professionals within the organization. The DMAIC (Design, Measure, Analyze, Improve, Control) problem solving method can be used to help with any issue that arises usually by those professionals in the organization who have reached green belt level. The Six Sigma approach looks at getting organizations to perform their processes in a more efficient manner to reduce defects. The next step for organizations is not only to improve processes but to make them more cost efficient or to adopt more efficient new processes; is the basis for Lean Six Sigma.

2.1 Success using Lean Six Sigma

Many companies are adopting Lean Six Sigma and having great success not only in manufacturing but in other industries including service industries. This is due to the fact the Lean looks at the needs of the customer and making the customer happy not only benefits the relationship with that customer but the process used to achieve that will help to increase customer satisfaction for current as well as future customers.

2.2 Why Six Sigma ?

- Six Sigma's aim is to eliminate waste and inefficiency, thereby increasing customer satisfaction by delivering what the customer is expecting.
- Six Sigma is a highly disciplined process that helps us focus on developing and delivering near-perfect products and services.
- Six Sigma follows a structured methodology, and has defined roles for the participants.
- Six Sigma is a data driven methodology, and requires accurate data collection for the processes being analyzed.
- Six Sigma is about putting results on Financial Statements.
- Six Sigma is a business-driven, multi-dimensional structured approach to:
 - Improving Processes
 - Lowering Defects
 - Reducing process variability
 - Reducing costs
 - Increasing customer satisfaction
 - Increased profits

The word *Sigma* is a statistical term that measures how far a given process deviates from perfection [3].

The central idea behind Six Sigma is that if you can measure how many "defects" you have in a process, you can systematically figure out how to eliminate them and get as close to "zero defects" as possible and specifically it means a failure rate of 3.4 parts per million or 99.9997% perfect.

2.3 Key concepts of Six Sigma

At its core, Six Sigma revolves around a few key concepts.

- **Critical to Quality:** Attributes most important to the customer.
- **Defect:** Failing to deliver what the customer wants.
- **Process Capability:** What your process can deliver.
- **Variation:** What the customer sees and feels as shown in fig 2.
- **Stable Operations:** Ensuring consistent, predictable processes to improve what the customer sees and feels.
- **Design for Six Sigma:** Designing to meet customer needs and process capability.

Our Customers Feel the Variance, Not the Mean. So Six Sigma focuses first on reducing process variation and then on improving the process capability

2.4 Myths about Six Sigma

There are several myths and misunderstandings about Six Sigma. Few are given below:

- Six Sigma is only concerned with reducing defects.
- Six Sigma is a process for production or engineering.
- Six Sigma can not be applied to engineering activities.
- Six Sigma uses difficult-to-understand statistics.
- Six Sigma is just training.

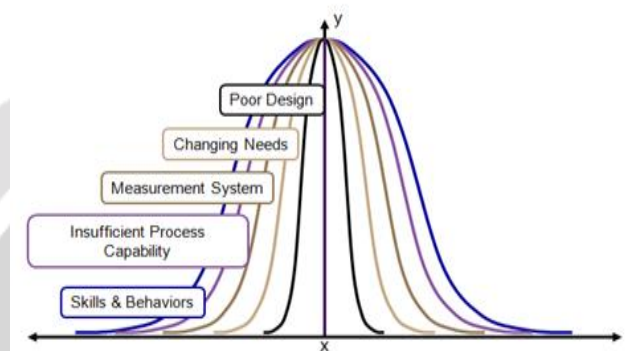


Fig 2 Sources of variation

2.5 The benefits of Six Sigma

There are following six major benefits of Six Sigma that attract companies.

Six Sigma:

- Generates sustained success.
- Sets a performance goal for everyone.
- Enhances value to customers.
- Accelerates the rate of improvement.
- Promotes learning and cross-pollination.
- Executes strategic change.

2.6 Basic steps involved in the application of Six Sigma

The DMAIC problem solving method that is a roadmap that can be used for any projects or quality improvements that needs to be made. The term DMAIC stands for the five main steps in the process; Define, Measure, Analyze, Improve and Control.[4]

- Define – It is important in Six Sigma to define the problem or project goals. The more specific the problem is defined the greater the chance of obtaining measurements and then successfully completing the project or solving the problem. The definition should describe the issue accurately with numeric representation; for example, “damaged finished goods from the production line have increased 17 percent in the last three months”. The definition of the problem or project should not be vague such as “quality has fallen”. As part of the definition stage, the scope of the project or issue should be defined as well as the business processes involved.
- Measure – When the project or problem has been defined then there needs to be decisions made on additional measurement that is required to quantify the problem. For example, if the definition of the problem is “damaged finished goods from the production line have increased 17 percent in the last

three months”, then additional measurements may be needed to look at what finished goods are damaged, when are they damaged, the level of damage, etc.

- Analyze – Once the measure stage has defined the addition measurements, the data is then collected and analyzed. At this point it is possible to determine whether the problem is valid or whether it is a random event that does not have a specific cause that can be corrected. The data that has been collected can be used as a base level to compare against measurements after the project has been completed to ascertain the success of the project.
- Improve – After measurements have been taken and analyzed then possible solutions can be developed. Test data can be created and pilot studies launched to find which of the solutions offers the best improvements to the issue when compared against the original measurements taken. The team should also look at the results to ensure that there are no unanticipated consequences to the selected solution. When the most appropriate solution is selected then the team can develop an implementation plan and a timeline for the completion of the project.
- Control – After the implementation of the solution or project there requires a number of controls to be put in place so that measurements can be taken to confirm that the solution is still valid and to prevent recurrence . The control measurements can be scheduled for specific dates, e.g. monthly, daily, and yearly, etc. The solution should also be well documented and any other related process documentation updated.

3. LEAN VERSUS SIX SIGMA

Lean Six Sigma is a methodology that combines process speed with quality . Lean, itself, focuses on speed. It emphasizes reducing the amount of time between activities, events, and cycles. The shorter the cycle time, the more cycles you can complete in a given amount of time. Lean also identifies areas where process waste and bottlenecks can be eliminated. There are 8 types of waste that can be removed from business processes to reduce costs and time:

- Waiting- whether it is for the next activity, process step, or information, process wait time can be 90% or more of the processing cycle.
- Overproduction- over producing products or services ahead of the need can result in product expiration or excess inventory
- Rework- correcting defects, mistakes and errors
- Motion- excessive movement/transfer of people, supplies, materials, and documents
- Over Processing- of information, data, and testing
- Inventory- maintaining excessive amount of supplies that could potentially expire
- Intellect- failing to use the talents and knowledge of the organization
- Unnecessary Transporting- equipment, people, etc.

While lean promotes rapid business processes the problem that arises from it is a lack of quality. It doesn't matter how many forms are completed or calls are taken if the data and information captured is not up to par. Simply completing activities rapidly, without check marks fosters an environment prone to errors and often requires rework. This is where Six Sigma becomes essential to business process management.



Fig 3 Lean Six Sigma approach

The Six Sigma methodology is a quality tool that emphasizes reducing the number of errors in a process. It focuses on identifying variation in the types of data inputs, and looks at Root Cause Analysis to determine the source of errors. After all, what good is it to complete a process quickly if the information is incorrectly entered. To ensure process and organizational success a combination of both lean and six sigma are needed. Together lean and six sigma work through process mapping to model and automate the most efficient, quality workflows

possible, allowing your company to maximize productivity, while eliminating waste and reducing costs. Having a Lean Six Sigma approach to your business processes is essential for any company to achieve operational excellence as shown in fig 3.

You'll also hear from certain people that software is not necessary for Lean Six Sigma execution. Sure, it's not necessary if you only want to receive a fraction of the possible results; but, why only go through process of making your manual tasks lean? If you automate your tasks with a Lean Six Sigma approach you are likely to receive an infinitely higher return on your efforts.

3.1 Why Lean Six Sigma

Lean Six Sigma is a managerial concept combining Lean and Six Sigma that results in the elimination of the seven kinds of wastes / *muda* (classified as Transportation, Inventory, Motion, Waiting, Overproduction, Over-Processing, and Defects) and provision of goods and service at a rate of 3.4 defects per million opportunities (DPMO). A mnemonic for the wastes is "TIMWOOD". The Lean Six Sigma concepts were first published in the book titled *Lean Six Sigma: Combining Six Sigma with Lean Speed* by Michael George in 2002. Lean Six Sigma utilises the DMAIC phases similar to that of Six Sigma. The Lean Six Sigma projects comprise the Lean's waste elimination projects and the Six Sigma projects based on the critical to quality characteristics. The DMAIC toolkit of Lean Six Sigma comprises all the Lean and Six Sigma tools as shown in fig 4. Lean Six Sigma were developed at a time when computers were not in widespread use. Today the situation is completely different. It seems very important to take into account in Lean Six Sigma projects also about automation. A rule of thumb coming from many years of application at GE is that the benefits of a Lean Six Sigma project come roughly 50% from organizational and layout modifications and 50% from digitization.

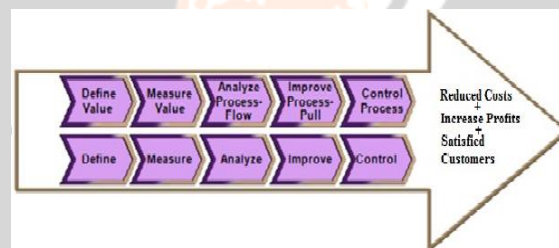


Fig 4 Combination of Lean and Six Sigma

3.2 Lean Six Sigma methodology

In its simplest terms Lean and Six Sigma are ways to improve business. Together they create a methodology which if followed will dramatically improve business processes, the attitude of people in the business and the results for customers in terms of quality and delivery. The ultimate outcome is the business can reduce costs, increase profits and obtain more satisfied customers. It does this by using simple tools and techniques to identify where we have issues in the business and then solves these problems in a structured way, using data and some easy methods to eliminate the issues permanently.

The methods, tools and techniques have been around for decades and we will know some of them. What makes the whole system work is putting a structure in place in your organization, getting everyone to buy into that concept and then training people not only in the tools, techniques and methods but in some basic implementation and people skills such as facilitation, change management, how to work with people and in teams, how to sell and present as well as how to manage a problem solving project.

The simple truth is there is no golden solution to business problems. We just have to work at them in a methodical and structured way with the commitment of staff and with trained and effective people. Lean Six Sigma gives a structure to make the improvements.

Lean Six Sigma is a business improvement methodology which combines (as the name implies) tools from both Lean Enterprise (Manufacturing) and Six Sigma. Lean eliminates the waste in your processes, while Six Sigma ensures quality through the elimination of variation in your processes and also provides a structured data driven structure to solve problems and implement sustainable change into your business. We believe therefore that the best approach for any business is to use Lean Six Sigma rather than one or the other. The benefits from taking

this approach are proven to out way taking only one approach at a time. To understand Lean Six Sigma let us first explain the two methodologies.

Six Sigma is a set of practices originally developed by Motorola to systematically improve processes by eliminating defects. A defect is defined as nonconformity of a product or service to its specifications. In other words every time you do an activity you get exactly the same outcome (result), the same quality. For example if I fill in a form or take an order or solve a customer issue or make a part no matter who does it the output is the same.

Top companies all over the world including Motorola have made Six Sigma a way of life for their business. This however requires commitment to the approach from top management down. If this is achieved then implementation and acceptance is easier and leads to massive savings. Motorola have made \$17b savings up to 2006 using the approach. It ensures that everyone focuses on reducing variation in every aspect of the business from filling in forms to making a part. All activities in a business of any kind can be measured, analyzed, improved and controlled and thus using some simple tools can give a reduction in variation leading to improved quality and costs.

Why do we want a reduction in the variation we obtain from any activity in our business? When we have the same output from a process or activity we know what we are going to get which makes the next step in the process easier and quicker to complete. It reduces the amount of time wasted completing a task and it means that the quality of a part or process step is higher reducing the need to rework or redo the activity. The simplest analogy is to think of golf and putting into the hole. If every time you took a putt you got the ball into the hole think how good that process would be, now think how good your putting is. In business if every time a part was made it was identical in every way to how it was meant to be - shape, form, look, feel etc that would mean we would have no quality issues. If we were completing a form and every time every field was correct, easy to read, all data correct, all numbers correct and it was the right form think how quickly things would be done. Well that is what Six Sigma is all about reducing the variation in everything you do.

The term "Six Sigma" refers to the ability of activities or processes to produce output within specification. In particular, processes that operate with Six Sigma quality produce at defect levels below 3.4 defects per (one) million opportunities (DMO). Six Sigma's implicit goal is to improve all processes to that level of quality or better. That would mean that every time you did something one million times you would only make a mistake 3.4 times.

To achieve these improvements in variation and therefore quality improvements and cost reduction Six Sigma uses an approach to solve problems (sources of variation) which is a standard methodology which everyone must use when solving problems regardless of size. DMAIC which was inspired by Deming's Plan-Do-Check-Act cycle is a sequence which if followed will ensure that not only will the root causes be identified but the best solution will be found then implemented into the organization permanently rather than for a short period before it goes back to how it was. If you are designing a new process or product then the methodology used would be DMADV.

3.2.1 DMAIC

Basic methodology consists of the following five steps:

- *Define* the process improvement goal or problem to be solved this should be consistent with customer requirements and the business strategy.
- *Measure* the current process and collect relevant data for future comparison.
- *Analyse* to verify relationship between factors and to identify the real root causes ensuring that all factors have been reviewed.
- *Improve* or optimize the process based upon various analysis tools to identify a number of solutions and then using data determine the most optimum for the problem

Control to ensure that the solutions is implemented into the organization and embedded so that it is does not return. This uses a series of tools and techniques to continuously measure the process and institute control mechanisms.

Basic methodology used for designing a new process or product consists of the following five steps:

- *Define* the goals of the design activity that are consistent with customer requirements and business strategy.
- *Measure* and identify CTQs (critical to qualities), product capabilities, production process capability, and risk assessments.
- *Analyse* to develop and design alternatives, create high-level design and evaluate design capability to select the best design.
- *Design* details, optimize the design, and plan for design verification.
- *Verify* the design, set up pilot runs, implement production process and handover to process owners.

Many people get confused by Six Sigma and believe that it is simply a case of applying a number of tools. This has led to many failed implantations of the methodologies. Other people are put off Six Sigma by the amount of data collection and analysis which is used. Simply put Six Sigma is all about data, if you have not got data you are just another person with an opinion. One of the reasons Six Sigma has been so successful in companies such as Motorola is that it is all data driven the methodology makes you use the data, analyze the data and then come up with solutions. To do this you must use statistics and tools which use stats to investigate and solve problems. As such typical tools used in Six-Sigma include:- Regression analysis, design of experiments and Chi-square testing may be used to define/identify within each sub-process, the possibilities for defects or quality problems. Statistical tools as well as conventional quality techniques like Brainstorming, Root –cause Analysis, Fishbone Diagram, Pareto analysis etc may be used for carrying out analysis. While implementing process controls in the final stage of six sigma implementation the POKA-YOKE (mistake-proof) devices can be set up to obviate the inadvertent errors to hold the gain that have been obtained from the improve stage. The idea POKA-YOKE is to respect the intelligence of workers by taking over repetitive tasks that depend on vigilance or memory. They can seem daunting and put off many people but the simple truth is that you don't have to know them all. You don't even need to use them all. It is good ideas to have one or two people in your organization who have detailed knowledge of them all you have to do is to know when they should be used then call in the experts. When used properly Six Sigma can dramatically reduce variation in your processes and lead to massive savings. However when coupled with Lean it becomes even more powerful.

Lean as the name suggest is the production of products or services using the least of everything - human effort, investment in inventory, machines, space, tools, time, development, transport / movement. The term is called Lean, Lean Manufacturing and Lean Enterprise all meaning the same thing and deriving from the Toyota Production system and some other sources. It is however very simply the reduction of waste from your processes it has enabled Toyota to become one of the biggest and most reliable car companies in the world. Lean is therefore the identification and steady elimination of waste through the implementation of perfect first time quality approaches to work, standardization of processes, smoothing of flow, flexibility of work, long term relationships with customers and supplies and reduction in time leading to cost reduction and business improvement. To achieve this a number of tools have been developed which facilitate the removal of waste from processes and a number of methodologies to implement the principles.

In organizations where the principles of Lean are fully understood the people use the tools and techniques with out thought as eliminating waste and improving flow become the norm. Lean in its many guises has been around since the 1940's and has developed and adapted over the years to become one of the key business improvement methodologies used in many of the world's leading companies. At its heart Lean is effectively simple and easy to understand. Lean implementation is therefore focused on getting the right things, to the right place, at the right time, in the right quantity to achieve perfect work flow while minimizing waste and inventor while being flexible and able to change if the customer requirements change. However, no matter how simple, at the heart of any Lean implementation is the cultural and managerial aspects of Lean which are just as, and possibly more, important than the actual tools or methodologies of Lean itself. There are many examples of Lean tool implementation without sustained benefit and these are often blamed on weak understanding of Lean in the organization. The first concept which must be understood is that waste is bad. This has been the ethos for successful companies from Henry Ford onwards. So what is waste?

Waste or non value added work is anything which doesn't add value to your product or service. When you examine your processes in real detail you discover that the vast majority of what we do is non value added. To illustrate this Shigeo Shingo (a deep Lean thinker) observed that it's only the last turn of a bolt that tightens it - the rest is just movement. If we review everything we do to this extent we see that most of our activities are waste. To eliminate waste we must examine three aspects - the design and planning of our activities, the

fluctuation at our operations such as quality and volume and thirdly the waste in our processes themselves in the movement of people and materials and the machines they use. When you examine your processes in this way you can be said to be, learning to see and can start to eliminate the waste and improve the processes. To make things easier there are 7 ways to think about waste.

The original seven wastes are:

- Overproduction (production ahead of demand) - making things ahead of when the customer actually wants them. We do this because our processes are not reliable, or we like to manufacture or do task in big batches (traditionally accountants tell us this is the most efficient way)
- Transportation - moving parts, materials or work in progress around a factory or paper around an office
- Waiting - for parts or information so you can perform at task
- Inventory (all materials, work-in-progress and finished product) - Items produced which can't be used or sold straight away go into inventory tying up money, space and causing multiple management issues
- Motion -people or equipment moving or walking more than is required to perform the processing
- Over Processing - making more than is needed or doing more work than is needed because you can't guarantee what the outcome will be i.e. I need 20 but I will make 25 just in case something goes wrong
- Defects / Rework - the effort involved in inspecting for and fixing defects, reworking items or having to scrap them

There has now been identified an 8th Waste

- Human talent - the waste of peoples talent - training, enthusiasm and brain power.

By identifying waste and non value added activities in our processes we can then start to use the Lean tools to eliminate them. Typical Lean tools include - 5S, visual management, TPM, SMED, Pokie Yokie, Standardized work, pull systems, takt time, single piece flow, Kanban, cellular manufacturing, design for manufacture, kaizen etc

Lean thinking and the tools associated with it have been used for decades all over the world by every type of business. There is a standard approach to implementation of Lean thinking.

- Step1: Specify Value
Define value from the perspective of the final customer. What does your customer actually want, what will they pay for and when do they want it.
- Step2:Map
Identify the value stream, all the actions required to bring a specific product through the physical flow of the company. This includes all the information flow and management flow steps to make things happen. Create a map of how it is today and how you want it to look like. Identify and categorize waste in the Current State, and eliminate it!
- Step3:Flow
Make the remaining steps in the value stream flow. Eliminate functional barriers and develop a product-focused organization that dramatically improves lead-time.
- Step4:Pull
Let the customer pull products as needed, eliminating the need for a sales forecast.
- Step5:Perfection
There is no end to the process of reducing effort, time, space, cost, and mistakes. Return to the first step and begin the next Lean transformation, offering a product which is ever more nearly what the customer wants.

If you have a top management team who understand the concepts and a workforce who embrace the culture then Lean will transform your business. As stated above Lean and Six Sigma when used together will provide a business improvement methodology which combines tools from both Lean Enterprise (Manufacturing) and Six Sigma. Lean eliminates the waste in your processes, while Six Sigma ensures quality through the elimination of

variation in your processes and also provides a structured data driven structure to solve problems and implement sustainable change into your business [5].

4. CONCLUSIONS

Like Six Sigma, Lean is a tool used by businesses to streamline manufacturing and production processes. The main emphasis of Lean is on cutting out unnecessary and wasteful steps in the creation of a product so that only steps that directly add value to the product are taken. As far as Lean methodology is concerned, the only way to determine if something has value or not is to consider whether a customer would be willing to pay for it. Any part of the production that does not add value is simply removed from the equation, leaving a highly streamlined and profitable process in place that will flow smoothly and efficiently as shown in fig.5.



Fig 5 Lean Value Stream

Essentially, Six Sigma and Lean systems have the same goal. They both seek to eliminate waste and create the most efficient system possible, but they take different approaches toward how achieving this goal. In simplest terms, the main difference between Lean and Six Sigma is that they identify the root cause of waste differently. Lean practitioners believe that waste comes from unnecessary steps in the production process that do not add value to the finished product, while Six Sigma proponents assert that waste results from variation within the process. Of course, there is truth in both of these assessments, which is why both Lean and Six Sigma methodologies have been so successful in improving overall business performance in a variety of fields. In fact, these two disciplines have proven to be especially successful when working in tandem - hence the creation of Lean Six Sigma. It is concluded that to become a truly more efficient and effective organization in terms of operations and business processes, you must have both Lean and Six Sigma methodologies; having one without the other ultimately results in process destruction.

REFERENCES

- [1]. De Feo, Joseph A.; Barnard, William (2005). *JURAN Institute's Six Sigma Breakthrough and Beyond - Quality Performance Breakthrough Methods*. Tata McGraw-Hill Publishing Company Limited. ISBN 0-07-059881-9.
- [2]. R. Leroy Coryea; Carl E. Cordy; LeRoy R. Coryea (27 January 2006). *Champion's Practical Six Sigma Summary*. Xlibris Corporation. p. 65. ISBN 978-1-4134-9681-9.
- [3]. Harry, Mikel; Schroeder, Richard (2000). *Six Sigma*. Random House, Inc. ISBN 0-385-49437-8
- [4]. Mikel J. Harry; Prem S. Mann; Ofelia C. De Hodgins; Richard L. Hulbert, Christopher J. Lacke (20 September 2011). *Practitioner's Guide to Statistics and Lean Six Sigma for Process Improvements*. John Wiley and Sons. pp. 30-. ISBN 978-1-118-21021-5.
- [5]. Paul A. Keller; Paul Keller (16 December 2010). *Six Sigma Demystified*. McGraw-Hill Professional. p. 40. ISBN 978-0-07-174679-3.