CHAPTER-1

INTRODUCTION

1.1 Introduction

The roots of Six Sigma as a measurement standard can be traced back to Carl Frederick Gauss (1777-1855) who introduced the concept of the normal curve. Six Sigma as a measurement standard in product variation can be traced back to the 1920's when Walter Shewhart showed that three sigma from the mean is the point where a process requires correction. Many measurement standards (Cpk, Zero Defects, etc.) later came on the scene but credit for coining the term "Six Sigma" goes to a Motorola engineer named Bill Smith.Six Sigma is a philosophy that works for the improvement of quality.Along with the improvement it has shown its results in increasing the profit and reducing the costs.Six Sigma brings us nerar to perfection.The more this is used,the more improvement is obtained.The main objective of this project is to reduce the rejection level of the selected product to enhance the quality and profit.With the help of this project it will be identified that whether Six Sigma really works well for improvement or just a concept.

1.2 What is Six Sigma

In statistical terms, the purpose of Six Sigma is to reduce process variation so that virtually all the products or services provided meet or exceed customer expectations. This is defined as being only 3.4 defects per million occurrences. Six Sigma was developed by Motorola in the 1980s but has its roots in Statistical Process Control (SPC), which first appeared in 1920s. Six Sigma is lots of different things because it had different meanings over time, and also because it is now interpreted in increasingly different ways. And Six Sigma is still evolving.

The UK Department for Trade and Industry says Six Sigma is: "A data-driven method for achieving near perfect quality. Six Sigma analysis can focus on any element of production or service, and has a strong emphasis on statistical analysis in design, manufacturing and customer-oriented activities." June 2005.

Six Sigma according to **Motorola**,"Six Sigma has evolved over the last two decades and so has its definition. Six Sigma has literal, conceptual, and practical definitions. At Motorola University (Motorola's Six Sigma training and consultancy division), we think about Six Sigma at three different levels:

As a metric

As a methodology

As a management system

Six Sigma according to **General Electric**

"Six Sigma is a highly disciplined process that helps us focus on developing and delivering near-perfect products and services. Why 'Sigma'? The word is a statistical term that measures how far a given process deviates from perfection. 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. To achieve Six Sigma Quality, a process must produce no more than 3.4 defects per million opportunities. An 'opportunity' is defined as a chance for nonconformance, or not meeting the required specifications. This means we need to be nearly flawless in executing our key processes 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

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..."

Teams and team leaders are an essential part of the Six Sigma methodology.

Six Sigma is therefore a methodology which requires and encourages team leaders and teams to take responsibility for implementing the Six Sigma processes. Significantly these people need to be trained in Six Sigma's methods - especially the use of the measurement and improvement tools, and in communications and relationship skills, necessary to involve and serve the needs of the internal and external customers and suppliers that form the critical processes of the organization's delivery chains.

Training is therefore also an essential element of the Six Sigma methodology, and lots of it.

Consistent with the sexy pseudo-Japanese 'Six Sigma' name (Sigma is in fact Greek, for the letter 's', and a long-standing symbol for a unit of statistical variation measurement), Six Sigma terminology employs sexy names for other elements within the model, for example **'Black Belts'** and **'Green Belts'**, which denote people with **different levels of expertise** (Champion, Master Black Belt, Black Belt, and Green Belt according to an extent.

The term “sigma” is used to designate the distribution or the spread about the mean of any process. Sigma measures the capability of the process to perform defect-free work. A defect is anything that results in customer dissatisfaction. For a business process, the sigma value is a metric that indicates how well that process is performing. Higher sigma level indicates less likelihood of producing defects and hence better performance.

Six sigma is a performance standard to achieve operational excellence. With six sigma, the common measurement index is “defects-per-unit” where a unit can be virtually anything – a component, piece of material, administrative form etc. Conceptually, six sigma is defined as achieving a defect level of 3.4 ppm or better. Operationally, six sigma is defined a staying within half the expected range around the target. The approach aims at continuous improvement in all the process within the organisation. This works on the belief that quality is free, in that the more we work towards zero-defect production, the more return on investment we will have. The advantages of six sigma approaches are reduction in defects/rejections, cycle time, work in progress etc. and increase in product Quality

1.3 Motivation & Objectives:

The motivation of this project was provided by the requirement of improving the quality of chassis 260 l & hence reducing the rejection level which caused a lot of rejection cost ealier.It was a major problem in industry (JBMA,GR. NOIDA) due to which a lot of customer problems were arising from customer(SAMSUNG INDIA LTD.).That is why this project is being done to avoid these problems so that the rejection level as well as rejection cost may be reduced.

This report includes the methodology of Six Sigma & its various aspects & its systematic application to present problem to eliminate the present issues.

1.4 Conclusion:

This chapter deals with the introduction to Six Sigma, Six Sigma definitions, and various key concepts related to Six Sigma.. With the help of Six Sigma it becomes easier to move towards perfection and improvement.Six Sigma is the philosophy with the help of which iot is possible to get the product as per the standards and customer requirement at reduced cost.So we can say that this philosophy leads us to improved quality with no compromise..

CHAPTER - 2

LITERATURE REVIEW

2.1 Intoduction

Efforts are being made from past time till now to control the defects and to get better quality of product.Many Quality tools and philosophies were discovered to get these results.Six Sigma is one of the most famous philosophy that was discovered to fulfill these requirements and succeeded to get the desired results to a great extent.Many Researchers,Engineers and Businessmen defined and used it in their own way.They had their own perception and definitions of Six Sigma.Some of the research papers have been used to have a review of Literature on Six Sigma below.

2.2 Literature Review

In the mid-1980s, Motorola, under the leadership of Robert W. Galvin, was the initial developer of Six Sigma. Most credit the late Bill Smith for inventing Six Sigma; Smith, a senior engineer and scientist within Motorola's Communications Division, had noted that its final product tests had not predicted the high level of system failure rates Motorola was experiencing. He suggested that the increasing level of complexity of the system and the resulting high number of opportunities for failure could be possible causes for this. He came to the conclusion that Motorola needed to require a higher level of internal quality, and he brought this idea to then-CEO Bob Galvin's attention, persuading him that Six Sigma should be set as a quality goal. This high goal for quality was new, as was Smith's way of viewing reliability of a whole process (as measured by mean time to failure) and quality (as measured by process variability and defect rates).

Motorola had always been a pioneer in the areas of productivity and quality. In the 1980s, Motorola had been the site for presentations of quality an productivity improvement programs by a number of experts, including Joseph M. Juran, Dorian Shainin (our colleague at Rath & Strong), Genichi Taguchi, and Eliyahu Goldratt. Mikel Harry, now president of the Six Sigma Academy and coauthor of *Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations,* was an attendee of some of these programs; inspired in part by their thinking, he developed a program for the Government Electronics Division of Motorola that included Juran's quality journey, Statistical Process Control (SPC), and Shainin's advanced diagnostic tools (ADT) and planned experimentation (PE).Harry then worked with Smith on the Six Sigma initiative. Harry led Motorola's Six Sigma Institute and later formed his own firm specializing in the subject. Smith and Harry's initial Six Sigma umbrella included SPC, ADT, and PE. Later, they added Design for Manufacturability (product capability and product complexity), accomplishing quality through projects and linking quality to business performance.Meeting the challenge Galvin had set in 1981 to improve quality by tenfold and developing Six Sigma helped Motorola to win the first alcolmBaldrige National Quality Award in 1989. In line with Galvin's policy openness and in response to the interest generated by the Baldrige Award,Motorola shared the details of its Six Sigma framework widely.

In the mid-1990s, AlliedSignal's Larry Bossidy and GE's Jack Welch saw in Six Sigma a way to lead their organizations' cultural change through Six Sigma initiatives and also achieve significant cost savings. In 1998, *Business Week* reported that GE had saved $330 million through Six Sigma, double Welch's previous prediction. Interest in Six Sigma really took off after that article appeared, an nterest that was fed by GE's continued success with Six Sigma and Jack Welch's speeches and books.

The Six Sigma of today speaks the language of management: bottom-line results. It institutionalizes a rigorous, disciplined, fact-based way to deliver more money to the bottom line through process mprovement and process design projects—selected by the top leadership and led by high potentials trained as Black Belts or Master Black Belts in Six Sigma—that aim to create near-perfect processes, products, and services all aligned to delivering what the customer wants. In successful im plementations, the majority of Six Sigma projects are selected for measurable bottom-line or customer impact that is completed within two to six months. The projects deliver through the application of a well-defined set of statistical tools and process improvement techniques by well-trained people in an organization that has made it clear that Six Sigma is a career accelerator.In our practice, we see companies viewing Six Sigma in two ways: as a set of powerful tools for improving processes and products and as an approach for improving both the process- and people-related aspects of business performance.

Six Sigma is used as a hands-on approach to developing leadership and change management skills. The companies that achieve the greatest benefits from Six Sigma leverage the linkages between people, processes, customer, and culture. In its 2000 annual report, GE describes the changes brought by Six Sigma this way: "Six Sigma has turned the Company's focus from inside to outside, changed the way we think and train our future leaders and moved us toward becoming a truly customer-focused organization.

While Six Sigma was invented at Motorola in the late 1980s, Six Sigma has had antecedents over the past 100 years. In this section we highlight some of the important developments, methodologies, and lessons learned that Six Sigma integrates.As far back as 1776, in *The* Wealth of Nations, Adam Smith identified the economies of scale made possible with specialization in manufacturing. During the arly years of the twentieth century, systems were developed for disaggregating manufacturing work rocesses into subsystems and components in the effort to increase efficiency. Modern organizations are still based on the specialization of labor and the fragmentation of processes into simpler tasks.

These principles are generally thought of as starting with Frederick W. Taylor and the scientific theory of management. We'll start our look backward with Taylor.

It is enlightening to compare how various companies—including leading proponents of Six Sigma—define it for their employees and their customers.

According to General Electric Six Sigma is the road map to customer impact."First, what it is not. It is not a secret society, a slogan, or a cliché. Six Sigma is a highly disciplined process that helps us focus on developing and delivering near-perfect products and services. Why 'Sigma'? The word is a statistical term that measures how far a given process deviates from perfection.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. Six Sigma has changed the DNA at GE—it is now the way we work—in everything we do and in every product we design."

TRW defines"Six Sigma is a structured and disciplined, data-driven process for improving business. TRW is committed to the implementation of Six Sigma focusing on how we can dramatically improve our competitiveness by increasing customer focus, enhancing employee involvement, instilling positive change into our culture and ultimately creating bottom and top line growth. At the highest level, Six Sigma is all about satisfying customer needs profitably. It is a highly disciplined methodology that helps develop and effectively deliver near-perfect products and services. It will help TRW in all of our operations, engineering, manufacturing and staff areas."

According to Honeywell "Six Sigma is one of the most potent strategies ever developed to accelerate improvements in processes, products, and services, and to radically reduce manufacturing and/or administrative costs and improve quality. It achieves this by relentlessly focusing on eliminating waste and reducing defects and variations.

“Leading-edge companies are applying this bottom-line enhancing strategy to every function in their organizations—from design and engineering to manufacturing to sales and marketing to supply management—for dramatic savings.

“Now, Honeywell has developed a new generation of Six Sigma . . . Six Sigma *Plus* is Morris Township, NJ–headquartered Honeywell’s principal engine for driving growth and productivity across all its businesses, including aerospace, performance polymers, chemicals, automation and control, transportation,and power systems, among others. In addition to manufacturing, Honeywell applies Six Sigma Plus to all of its administrative functions.Now question arises Was Six Sigma Part of the natural progression of quality, or was it a totally new event and a new thrust?

In words of BOB GALVIN **“** I think it was both. You could lean either way in terms of the natural intelligence that finally emerged. Was it a great discovery or just remarkably good mathematics and common sense? You can interpret it either way.”

In words of MIKEL HARRY :I think Six Sigma is now squarely focused on quality of business, where TQM is concerned with the business of quality. That is, when you adopt TQM, you become involved in the business of doing quality,and when you adopt Six Sigma, you’re concerned about the quality of business.” In a nutshell, TQM is a defect-focused quality improvement initiative,whereas Six Sigma is an economics-based strategic business management system. Didn’t start off that way, but it has evolved that way. So I see Six Sigma as a vector change. As I look across the history of quality from the era of craftsmanship, it’s fairly continuous; each step is a logical continuance of the preceding step, built off the same fundamental core beliefs and principles, whereas Six Sigma represents a radical departure from that continuum. It’s actually a reassessment of quality from a whole new perspective and frame of reference. It's a reinvention of the history,if you will, but it's a birth of a new history, and that's the way to say it. It's been the evolution of a business management revolution.

Frederick W. Taylor's techniques,which became known as *scientific management,* made work tangible and measurable through analyzing manufacturing processes and turning them into a set of tasks that could be standardized and made repetitive. With work fragmented into a multitude of tasks, a managerial system was then required to control work. The concept of the separation of planning and execution was central to Taylor's system. Taylor advocated planning departments staffed by engineers with the following responsibilities:

• Developing scientific methods for doing work

• Establishing goals for productivity

• Establishing systems of rewards for meeting the goals

• Training the personnel in how to use the methods and thereby meet the goals

Taylor's system dealt a blow to the concept of craftsmanship in managing work or quality as a single end-to-end process. In 1911, *The Principles of Scientific Management,* a collection of his writings, was published. By the 1920s, Taylor's methods were widely adopted and Taylor's ideas had influence across the globe.

Henry Ford adopted four principles in his goal to efficiently produce an automobile at an affordable price: interchangeable parts, continuous flow, division of labor, and a reduction of wasted effort. Influenced by Taylor's ideas and Ford's own observations of improved work flow in other industries, the assembly of the Model T, first produced in 1908,was broken down into 84 distinct steps, with each worker trained to do just one. Ford had Taylor do time-and-motion studies to determine the exact speed at which the work should proceed and the exact motions workers should use to accomplish their tasks. In 1913, Ford's experiments and innovations came together in the first moving assembly line used for large-scale manufacturing. Ford’s early methods are a foundation of Just-in-Time and Lean Manufacturing.

Quality engineering can trace its origins to the applications of statistical methods for control of quality in manufacturing. Much of the early work was done at Bell Telephone Laboratories,where bothWalter Shewhart and Dr. Joseph M. Juran worked in the 1920s. In 1924, Shewhart first sketched out the control chart.What has survived of that early work is the Shewhart control chart and what has become known as *Statistical Process Control.* Shewhart’s work laid the foundation not only for the use of engineering methods to specify work processes, but also for the use of statistical methods that quantify the quality and variability of processes.

Japanese upper management—presidents and general managers—assumed the leadership of the quality function in response to the quality emergency of the 1950s. Shoddy quality had made Japanese goods uncompetitive. The postwar rebuilding of Japanese industry was seen by industry leaders as a unique opportunity to radically deal with this problem. Dr. W. Edwards Deming, Dr. Armand Feigenbaum, and Dr. Joseph M.Juran are widely credited with helping the Japanese revolutionize their quality and competitiveness after World War II, and they served as consultants to the Japanese in the ensuing decades. The three became prominent in the United States after the Japanese quality revolution struck fear into American business. Although their contributions are many and complex, what we want to do here is simply point out contributions that are important to our understanding of the origins of Six Sigma.

Dr. W. Edwards Deming. Known for introducing statistical quality control to Japan, Deming also placed great importance on the responsibility of management,believing it to be responsible for 94 percent of quality problems.

Deming is also associated with the “plan-do-check-act” (PDCA) cycle as a universal improvement cycle (also known as the Shewhart cycle, as Shewhart first advocated its use).**Dr. Joseph M. Juran.** Juran developed the quality trilogy—quality planning, quality control, and quality improvement. Juran associated quality with customer satisfaction and dissatisfaction, emphasized ongoing quality

improvement through a succession of improvement projects, and believed upper management leadership of the quality function was critical. Juran also emphasized reducing the cost of poor quality as a key to competitiveness.

Dr. Armand Feigenbaum. Known as the originator of “total quality control” or “total quality,” Feigenbaum defined *total quality* as an effective system to ensure production and service at the most economical levels that allow customer satisfaction.

Japanese companies chose to train almost all managers in the science of quality. Unlike in theWest, quality responsibility and training were not confined to members of specialized quality functions. From the 1950s onward, Japanese companies undertook a massive training program in quality for employees and instituted annual programs of quality improvement. They also instituted a project concept of quality improvements. Improvement breakthroughs were made project by project under the guidance of managers who selected the improvement projects and mobilized and guided project teams.

The Toyota Production System (TPS) is perhaps the premier example known in the West of these Japanese methodologies. Its practices— kanban and quality circles, for example—have been widely studied and used in the West, often without achieving the same results. In the 1970s,TPS was equated with Just-in-Time production methods. Stephen Spear and H. Kent Bowen believe the reason that U.S. companies have rarely achieved the kind of results that Toyota has is that they confuse the tools with the system itself. According to Spear and

Bowen's research, four basic rules capture the tacit knowledge that underlies the Toyota Production System:

1. All work shall be highly specified as to content, timing, and outcome.

2. Every customer-supplier connection must be direct, and there must be an unambiguous yes-or-no way to send requests and receive responses.

3. The pathway for every product and service must be simple and direct.

4. Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization.

In this system, expert knowledge requires the addition of the knowledge of the people doing the work to improve the process; the people doing the work need the guidance and help of leader-teachers to apply the scientific method in a controlled project to achieve improvement. In the Toyota Production System and in Japanese concepts of quality in general, processes, people,and behaviors are seen as inextricably linked in a culture of continuous improvement. Loss of market share, especially dramatic in the automotive and electronic industries, ultimately led to a reinvention of manufacturing in North America,beginning with the rediscovery of Statistical Process Control (SPC) and the introduction of quality circles, through Just-in-Time (JIT) and Total Quality Management (TQM) to business process reengineering (BPR) to Lean Manufacturing and Six Sigma.

Now we shall proceed to second generation of Six Sigma.To put Six Sigma in perspective, we started by discussing the beginnings of Six Sigma in the 1980s and then its antecedents from the early twentieth century to the recent history of TQM, JIT, and Lean. The Six Sigma of the late 1980s and early 1990s—the first generation—was part of continuous improvement or total quality efforts at companies that were led for the most part by quality professionals. These efforts often became islands of isolated change that died when unsupported by the business leadership. What can be called the second generation of Six Sigma can be fairly said to have first emerged at AlliedSignal in 1994, where it was led by CEO Larry Bossidy. Hallmarks of the second generation are that Six Sigma is part of the corporate business plan and is key to achieving business objectives, with top leadership support and often intimate involvement. Another key difference from the first generation is that the second generation of Six Sigma starts with the Voice of the Customer. In its first generation, Six Sigma process improvement methodology included four logically linked phases: measure-analyze-improvecontrol.

In the second generation, during the GE Capital deployment in 1995,a new first phase, *define*, was added, becoming the DMAIC methodology now used in most Six Sigma implementations. In the define phase, data is used to verify customer needs and requirements and to identify the Critical-to-

Quality characteristics for customer satisfaction. The define phase guarantees that theVoice of the Customer is central to every Six Sigma project by adding rigor to the front end of the methodology.

Wasn't GE Capital the First Business to Add the D to the MAIC Road Map?

Had to! We didn't know where to start. We had to start with define. We couldn't see our processes. If I were, say, manufacturing a widget, if I wanted to fix this problem, I would know that it came from this part of the assembly line. I could see it. But without D, you didn't understand where you were starting. You didn't understand process mapping. You didn't understand what a process was like. By the way, even the word process wasn't well understood in financial services.. And by integrating process improvement (DMAIC), process, product and service design (i.e., Design for Six Sigma, or DFSS), and process management into a comprehensive approach to implementing business strategy, Six Sigma finally evolved into a program that could be used to drive the business instead of narrowly focusing on quality. In the May 2002 issue of Six Sigma Forum, Matt Barney of Motorola tells how the second generation of Six Sigma differs from the first generation at the place of Six Sigma's birth:

Executive ownership Self-directed work teams

Business strategy execution system Quality initiative

Truly cross-functional Largely within a single function

Focused training with verifiable No mass training in statistics and return quality

Business results oriented Return on investment

Quality oriented

No less an authority than Dr. Joseph M.Juran has said that while he does not see any significant advances in Six Sigma, he does think it has succeeded in gaining the participation and commitment of top leadership, a critical success factor that every other process improvement program failed to achieve, with a few notable exceptions, such as Motorola under Bob Galvin's legendary leadership.

What makes Six Sigma so attractive is that it integrates a great deal of what we have learned about getting sustainable results in manufacturing and services. But in seeing Six Sigma as part of that evolution, it would be a mistake to think of Six Sigma as about evolutionary, incremental improvement. From the stretch performance targets set for Six Sigma projects to transforming the mind-sets of the current generation and next generation of leaders through Black Belt and Master Black Belt training and successful projects, Six Sigma is about big paybacks and big impacts on culture and leadership.

The world is concluding that the way to become a world-class company is to create superior process performance, as that is what ensures superior products and services for customers. Superior process performance maximizes value for the customer and the shareholder. The beauty of Six Sigma is that it can be applied again and again to improve processes or to design new processes that continuously align the company with changing customer needs and wants. Change is always difficult. Established organizational structures and expert functional areas are resistant. To change the way work is done in the hierarchical structures that are today's corporations, leaders need to drive the effort. An advantage of Six Sigma is that it requires leaders to be actively engaged in leading the pursuit of customer satisfaction. Also, the idea of process improvement through projects that is at the heart of Six Sigma is very powerful because it leverages the human factor in change at both the leadership and the process levels. The people who work in the process become the change agents using the Six Sigma tool kit. Changing processes changes behavior. However, changes in culture—the "collection of overt and covert rules, values,and principles that are enduring and guide organizational behavior" can only be driven by the organization's leaders. To effect cultural change with Six Sigma, it must be aligned with strategy and leader behavior. Here are some ways in which leaders reinforce the kind of culture and organization they wish to create:

• By what they pay attention to, measure, and control

• By their reaction to critical issues in the organization

• By the way they model the role, teach, and coach

• By their criteria for rewards, promotion, and hiring

• By the questions they ask

When asked what role leaders need to play when driving change in their companies, Kenneth W. Freeman, chairman and CEO of Quest Diagnostics Incorporated, gave the following advice:

If you want to drive change in a company, you have got to do it with more than words. Yes, communication is vitally important. But you have to mesh that communication in terms of where you want the company to go with actually providing some participation on your own end in terms of modeling the behavior you want to have happen. This may sound kind of oldfashioned, but I really believe that in corporate America today, there are not a lot of companies where senior leaders are really willing to roll up their sleeves and do the work. Many people say that a CEO’s role is to delegate—just set the pronouncement and then come back next week or next month to make sure they did it. That’s fine for some companies, but I think if you really want to drive permanent change, you need to put your feet, not just your mouth, into the game. That is the single biggest thing a leader can do. My job is to set the example in driving accelerated commitment and strong performance.James Champy, in Reengineering Management: The Mandate for New *Leadership,* says that management’s agenda needs to be redefined: “If you haven’t gotten it by now, let me say it plainly: Purpose, culture, process, and people replace strategy, structure, and systems as our superordinate questions.”

Commitment to Six Sigma puts purpose, culture, process, and people— including the customer—squarely on the leader’s agenda.

2.3 Conclusion

Thus we can say that Six sigma background stretches back eighty plus years, from management science concepts developed in the United States to Japanese management breakthroughs to “TOTAL QUALITY “ efforts in 1970s and 1980s. But the real impacts can be seen in the waves of change and positive results sweeping such companies as GE, MOTOROLA, JOHNSON &JOHNSON and AMERICAN EXPRESS. Due to which this magical philosophy is doing well in present days.

CHAPTER-3

Implementation Procedure of Six Sigma

3.1 Introduction

Before applying six sigma we must know all of its elements.There are three basic elements to Six Sigma:

a. Process improvement

b. Process design/re-design

c. Process management

Each of the above three elements is examined in more detail below.

3.1.1 Process improvement

The purpose of process improvement is to eliminate the root causes of performance deficiencies in processes that already exist in the organization. These performance deficiencies may be causing real problems for the organization, or may be preventing it from working as efficiently and effectively as it could. To eliminate these deficiencies a five-step approach is used.

Define – a serious problem is identified and a project team is formed and given the responsibility and resources for solving the problem.

Measure – data that describes accurately how the process is working currently is gathered and analyzed in order to produce some preliminary ideas about what might be causing the problem.

Analyse – based upon these preliminary ideas, theories are generated as to what might be causing the problem and, by testing these theories, root causes are identified.

Improve – root causes are removed by means of designing and implementing changes to the offending process.

Control – new controls are designed and implemented to prevent the original problem from returning and to hold the gains made by the improvement.

3.1.2 Process design/re-design

Sometimes simply improving existing processes is not enough, and, therefore new processes will need to be designed, or existing processes will need to be re-designed. There are several reasons why this could be necessary:

- An organization may choose to replace, rather than repair, one or more of its core processes.
- An organization discovers, during an improvement project, that simply improving an existing process will never deliver the level of quality its customers are demanding.
- An organization identifies an opportunity to offer an entirely new product or service. As with process improvement, a five-step approach is used to

Define – identify the goals for the new process, taking into account the customer requirements.

Match – develop a set of performance requirements for the new process that match these goals.

Analysis – carry out an analysis of these performance requirements for the new process, and based upon this produce an outline design for the new process.

Design & Implement – work this outline design up into a detailed design for the new process, and then implement it.

Verify – make sure the new process performs as required and introduce controls to ensure it keeps performing that way.

3.1.3 Process management

Because it requires a fundamental change in the way an organization is structured and managed, process management is often the most challenging and time-consuming part of Six Sigma. In general, process management consists of:

● Defining processes, key customer requirements, and process “owners”.

● Measuring performance against customer requirements and key performance indicators.

●Analyzing data to enhance measures and refine the process management mechanisms.

● Controlling process performance by monitoring process inputs, process operation, and process outputs, and responding quickly to problems and process variations.

3.2 Steps for Process Improvement

Step 1 – Define

Having identified the improvement project to be carried out, the project needs to be established by carrying out the following activities:

●**Prepare a problem statement -** this statement must describe the problem in specific terms that identify: what is wrong; what is the visible evidence of the problem – the symptoms; how serious is the problem, expressed in quantifiable and measurable terms; how large is the problem – can it be addressed by a single, manageable size improvement project or will it need to be sub-divided into several smaller, manageable projects.

● **Prepare a mission statement-** this statement must describe what is going to be done about the problem, i.e., the objective of the improvement project. The mission statement should contain the same variable and unit of measure as does the problem statement.

● **Select a project team -** the project team selected should be a cross-functional team that spans all functions upon which the improvement project will have an impact, both direct and indirect.

Step 2 – Measure

During this Measure step, symptoms of the problem that exists are identified and a baseline measurement of current and recent performance is established. Also, a map of how the process that is producing the problem operates is developed. However, the real purpose of this step is to analyze the symptoms and then to confirm, or modify, the mission statement based upon the results of this analysis. In Six Sigma a symptom is defined as the outward, observable evidence of a problem. It is an output of the process that is producing the problem. If a symptom like this occurs on an ongoing basis, it signals a chronic, underlying quality problem that needs to be addressed. To address such a problem, first of all, the symptom needs to be analyzed in the following manner:

● Develop operational definitions

● Measure the symptom

● Define the boundaries – that is, the scope of the improvement project

● Concentrate on the vital few – those sources of error thought to be largely responsible for the problem. It is time consuming to attempt to tackle all possible sources, and the result may not justify the effort.

Once the above analysis of the symptoms has been completed, the mission statement should be revisited to confirm that it is still applicable, or to modify it to make it applicable. The results of the analysis may reveal that the problem is somewhat different from the one that was originally described; or that the improvement project is too large and needs to be broken down into more manageable parts.

Step 3 – Analyze

During this Analyze step, theories about the causes of the problem are formulated, these theories are tested, and, finally the root causes of the problem are identified.

● **Formulating the theories**– the project team brainstorms possible theories, documents them, and then organizes them in the form of a cause-and-effect diagram.

● **Testing the theories**– before any theory can be accepted as true, it must be systematically tested. Any data required to test a particular theory that is not available, must first be collected. If the data collected demonstrates that a particular theory is clearly not important, then that theory can be eliminated.

● **Identifying the root cause(s)** – once testing has been completed, the root cause(s) of the problem should be able to be determined. Once found, the removal of the real root cause(s) will sharply reduce or eliminate the problem/deficiency.

Step 4 – Improve During this Improve step, several sequential activities are performed and these are described below.

● **Evaluation of alternatives** – alternative improvement methods are evaluated to determine which method will best remove, or reduce the effect of, the root cause(s) of the problem. This evaluation is carried out using a set of evaluation criteria such as cost, impact; cost/benefit ratio, cultural impact etc

● **Design of the improvement** – an improvement method has been selected, the improvement process is designed by confirm that the improvement achieves the project goals; determining the required resources; specify the procedures and the other changes required; assessing human resource requirements to determine whether any training/re-training is required.

● **Plan for cultural resistance** – by their very nature, improvement efforts create change in an organization and "cultural resistance" is a natural consequence of change. Therefore, dealing with this potential cultural resistance needs to be factored into the improvement project plan.

● **Prove effectiveness** – before an improvement is finally adopted, it must be proven effective under operating conditions. This could be done with a pilot test; a dry run, which doesn t involve delivery to the customer; an acceptance test; a simulation

● **Implement** – this involves introducing the proposed change to the people that will make it work. This demands: a clear plan; a description of the change; an explanation indicating why the change is necessary; involvement of those affected; the change. The most important parts of implementation, though, are good planning, good preparation, and good cooperation between all of the individuals concerned.

Step 5 – Control

During this Control step, controls are put in place to ensure that the gains that have been achieved will continue and the problem will not recur. To do this the following activities need to be carried out.

● Design effective quality controls

● Foolproof the improvement

● Audit the controls

3.3 Implemetation roles

With any organizational change initiative, idea must have proof that it is a worthy pursuit, preferably along with examples of success stories from grassroots efforts or other companies. And an idea needs senior management support to evolve into an effective initiative that establishes long-term improvements. Six Sigma leaps such hurdles easily. No longer considered a risky quality approach by many senior managers, Six Sigma is considered a necessity to better meet the needs of their businesses. As a consequence of Six Sigma success in the manufacturing area, many organizations are considering implementing it as a mode of operations for transactional and administrative business processes. The critical component to seeing bottom-line results for Six Sigma is careful implementation. One of the fundamental inventions of Six Sigma is to introduce “professional” analysing of quality mangement functions.Six Sigma borrows martial arts ranking terminology to define a hierarchy (and career path) that cuts across all business functions and a promotion path straight into the executive suite. Six Sigma can be a great success or an expensive failure, depending on how it is implemented. Successful implementation should be viewed as ongoing process of fusing z sigma methodologies into an organization s culture such that employees use Six Sigma techniques when they approach their every day work. The implementation process is illustrated in figure 2, requires up front Corrective action, Waste removal to develop awareness and generate robust design before projects are started.

3.4 Six Sigma Infrastructures:

An infrastructure is what ensures that necessary resources are available when needed. In addition to senior management support, a solid infrastructure upon which to implement Six Sigma involves fostering a receptive culture and assigning the appropriate roles and responsibilities. Fostering a receptive culture takes time. This initially involves introducing the work force to the basic principles of Six Sigma and establishing pathways to both voice and address concerns. Otherwise, if the work force does not understand the principles of Six Sigma, it will not support the implementation. The best-practice distinction is that successful organizations then demonstrate Six Sigma's potential through small-scale successes and set goals linked to management compensation. The results of these efforts should be a culture in which operations are discussed in terms of customer satisfaction, defects, and business needs. Following the example of Six Sigma champions and specialists, thework force is encouraged to pose questions and verbalize problems in an objective and collaborative environment. Assigning the appropriate roles involves shifting the full-time responsibilities of a few, critical employees. Roles typically include an Executive Leadership, Six Sigma champion, Master Black Belts, Black Belts, and Green Belts. (Sometimes, additional roles are created, such as Yellow Belts and Brown Belts.) Those necessary roles and responsibilities are often determined by a Six Sigma steering committee. And the initiative often resides within a department as a stand-alone function, separate from other quality initiatives. Figure 3 represents the continuous roles managed and linkage between those roles played in an organization. Descriptions of the primary roles follow:

Executive Leadership includes CEO and other members of top management. They are responsible for setting up a vision for Six Sigma implementation. They also empower the other role holders with the freedom and resources to explore new ideas for breakthrough improvements.

The **Champion** role is critical. Often senior managers with a full-time commitment to Six Sigma, champions understand Six Sigma principles and have strategic ties to business units. They act as guides, mentors, and facilitators for the practitioners/Black Belts.

Master Black Belts with the highest level of training, act as teachers and mentors. Responsible for delivering results and handling multiple projects, Master Black Belts have especially strong leadership skills and must be respected in the organization in order to influence decisions. They assist champions and guide Black Belts and Green Belts. Apart from statistical tasks, their time is spent on ensuring consistent application of Six Sigma across various functions and departments.

Black Belts with an extensive level of training, guide improvement projects. Technically oriented, these individuals create, facilitate, train, and lead teams, with an analytical approach. The primary focus of Black Belt is lead/execution of project, whereas Champions and Master Black Belts focus on identifying projects/functions for Six Sigma.

Green Belts are qualified to solve the majority of process problems that arise in manufacturing environments and can always consult with Black Belts if they come up against a particularly challenging problem. Operated under a Black Belt

Yellow Belts represent everyone else on the team. They're not immersed in the details of the project but Yellow Belts are essential. They do apply some elements of the Six Sigma methodology as they help the Green Belt meet project goals and objectives. Yellow Belts are staff members, administrators, operations personnel and anyone else who might play a role.

Another important role in the Six Sigma method is Process Ownership. Process owners are generally used in the DMAIC and DFSS projects and are responsible for the management of processes within the organization. Process leaders can be current managers and leaders or can be promoted from a non-leadership position. A process owner is responsible for managing improved processes created by an improvement team. A process owner needs to have the following qualifications:

- An expert on the subject matter
- Someone who experiences problems with the poorly functioning processes and will benefit from the improved process
- A person who has a positive influence on others
- Able to communicate effectively with leaders of other processes
- Can think outside the box and create methods for improvement

Six Sigma projects should focus on core processes (i.e., not sublevel) that have been systematically selected by Champions, Master Black Belts, or other partners. The characteristics of an ideal Six Sigma project are:

- A connection to strategic and annual operating plans
- Recognition as being important to the organization
- A scope that can be completed within a reasonable time frame (typically, three to six months),
- Support and approval by management.

Now we have to discuss various quality management tools and methodologies used in Six Sigma.There are many Six Sigma quality tools and measurement representations. We are going to represent one of the famous tools used in many organizations to keep track the progress. It is Process Capability. A Six Sigma quality level process is said to translate to process capability index values for process capability index/process performance index. A PROCESS is a unique combination of tools, materials, methods, and people working in production of measurable output. These outputs can be evaluated by statistical methods.

The capability of a process is some measure of the proportion of in-specification items the process produces when it is in a state of statistical control. We have traditional method of calculating data called batch performance. The difference between batch performance and process capability are in batch performance we consider only the actual value produced,

but in process we are interested to know about the capability of process in statistical control. To calculate data, we consider all data should be in-control process, measureable mean and standard deviation. The important thing to mention is the specification limits are not determined by statistical data, but determined by customer requirements and economy of process.

We need to use the process capability of the process. Two parts of process capability are: 1) Measure the variability of a process, and

2) Compare that variability with a proposed specification or product tolerance.

A final observation can be done based on the specification limits. The indices can be used to add precision and may be easier to use as ongoing checks on a conforming process, but they are not terribly intuitive, and may be overkill in straightforward situations. Creating and implementing Six Sigma will not guarantee real benefits within an organization. But, when implemented wisely to a business strategy combined with other effective metrics, organizations can achieve benefits. The benefits are improved delivery time, reduced waste, and improved internal/external customer satisfaction. Though the six sigma success can be obtained only with wise implementation and sustain attention of executive management. This results a change in corporate culture to a learning organization. The cultural change within an organization through Six Sigma requires exposing the work force to Six Sigma, publicizing projects under way, and sharing the subsequent successes.

3.5 Six Sigma Implementation in Smaller and Mid-Sized Companies:

Large companies are making Six Sigma as an authoritative command to their supply base as a condition of doing future business. When small companies petition deployment proposals from Six Sigma consulting companies, they learn that the implementation of Six Sigma approach can require million of dollars in investment, dedication of their full time resources, and training of the masses. This approach to Six Sigma is unrealistic for smaller and mid-sized companies. There is a real need to accommodate smaller and mid-sized companies into the Six Sigma, because the nearly represent as much as 75%-80% of total value stream activity.

The top-down implementation of Six Sigma is a major barrier to the entry for smaller and mid-sized companies. Alternative Six Sigma deployment models allow smaller and mid-sized companies to implement at a pace where they can actually implement the methodology and reap benefits. This can be achieved without the huge resource commitment and overhead structure of the traditional Six Sigma Engineering Managemen.implementation approach. As a virtue of which smaller companies sometimes are able to gain faster and more benefits that their large customers. In the Six Sigma implementation cycle, majority of the benefits are not made from Black Belts but are derived from the Green Belt and Yellow Belt level, especially when the Six Sigma process becomes institutionalized. The Black Belts and Green Belts are interchangeable for about 80% of the company s Six Sigma opportunities. Many constraints of the smaller and mid-sized companies can be addressed by using Green Belt and Yellow Belt, thereby allowing them to implement at a manageable pace. Such companies become as technically skilled as their larger counterparts and in many cases they are outperforming their costumers in both financial aspect and cultural transformation.

Following Steps can be used for Six Sigma deployment and execution process for smaller and mid-sized organizations:

- Develop a Six Sigma strategy and overarching infrastructure**.** This step includes the strategy, implementation approach and projects that are directly aligned to the organization's strategic plan and customer requirements. It also includes well-organized communication and awareness building for Six Sigma.

- Implementation planning: For a high impact Six Sigma projects includes defining objectives, scope, goals, priorities, work plans, deliverables, baseline performance, and expected performance improvements.

- Begin Team formation and the education plan concurrently. The teams prevent time and resources debating over what needs to be done. Apart from it, education is modified according to business specific needs that include sample issues, data, and examples from their actual processes.

Although the Six Sigma approach is different in smaller and mid-sized organizations, executives in such companies should make sure that Six Sigma still requires the same leadership and commitment as in larger companies.

Some people should complete Green Belt certification which focuses on Six Sigma that also includes and integrates Kaizen and Lean. A program should stress deployment of the right tools to the right opportunities, because not all problems require a complex statistical approach.

Other team members should complete Yellow Belt certification which focuses on the basic "blocking and tackling" tools of Six Sigma, and also Kaizen and Lean.

As the Six Sigma Lifecycle progress, individuals are transitioned to the next level of Six Sigma achievement. New resources should be developed into Green Belts and Yellow Belts respectively based on need and the goal should be to ramp up to a point where the tangible savings is funding the Six Sigma program.

Certification should be given by achievement and not by attendance. Apart from the classroom, all certification candidates must complete a mandatory project which demonstrates the correct deployment of Six Sigma and solves a real business problem and achieves a targeted savings.

The above approach can be modularized so that the company can quickly transition their Six Sigma resources to the next highest level of achievement. Companies can accomplish their Six Sigma implementation at a more pace. The number of projects, the levels of education, and the whole deployment and execution approach occur at a pace that has a direct link to strategy and results. The above type of approach to Six Sigma helps smaller and mid-sized organizations to achieve results at a manageable pace and yields desired results. The "one size fits all" Six Sigma deployment model isn't pragmatic for all companies, and other deployment models should be explored. Smaller and mid-sized companies can be accommodated into the Six Sigma fold with the right deployment model.

CHAPTER-4

Six Sigma application to the present problem

4.1 Introduction

This project is taken for a Vendor Company of Samsung India Ltd.,Gr. Noida which is JBMA,Gr. Noida & manufactures Chassis for 260 L refridgerator of SAMSUNG.

The major issues were related to the quality of the product that is chassis 260 L.The cracks were being produced in this product heavily which wre not acceptable by customer.That is why there iwas a need of having control over these cracks.there might be many issues related to this defect as per following:-

Wrong handling of material

Improper quality of material being used

Wrong selection of method

Improper condition of tool

Various deficiencies in macjines itself

But it was not easy to find out the absolute reason for this defecet.This might be due to any one of the above reasons or due to the combination of some or all.So how to reach the absolute reason for the same and how to find out the solution.Thats why planning was done to use Six Sigma tools to find out the systematic reason and solution of the existing problem.

To solve any problem, the methodology adopted must cover all possible causes of the problem. If the methodology of problem solving is not comprehensive enough, the solution obtained at completion will not be correct and the problem will resurface sooner or later.

4.2 Define Phase

Mission Statement of the project: The mission statement covers two statements as following:

The Problem Statement:

Heavy rejection in Chassis 260/250L due to crack which leads to:

Low productivity

Increased process time

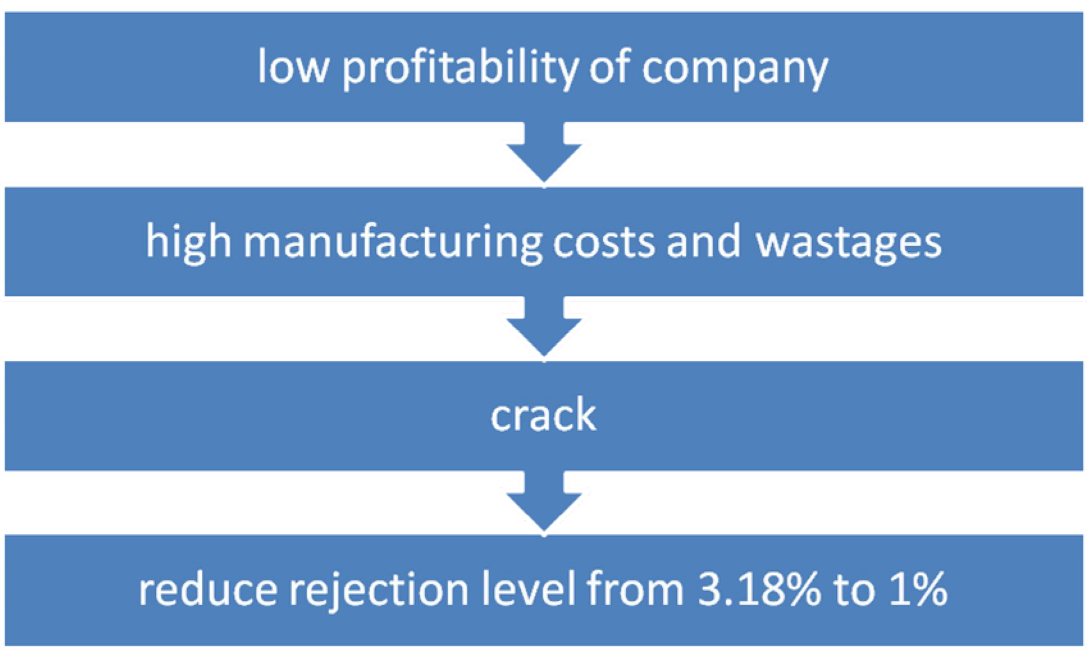
Scrap cost

May lead to supply delay

The Goal Statement:

To reduce the rejection level of Chassis 260/250L from 3.18% to 1% by March 2010

Drill Down Tree:



Project Development/Project Scoping:

This development uses the SIPOC term.which is a shaort form of various terms.It is illustrated as following for the existing project:

S-Supplier-

1.M/S Bhushan Steels & strips

2.HRD

3.Machine Supplier

4.Production Engineering Department

I-Input-

1.Raw material

2.Machine

3.Manpower

4.operation standerd

P-Process-

1.Draw

2.Trimming and Piercing

3.Trimming and Burring

4.Bending

O-Output-

1.Crack

C-Control-

1.Quality Assurance Department.

2.Samsung India Electronics

Inframe/Out Frame:

In this session We differentiate the the objective and its process which plays the vital role in producing the defect.In the present case the our product ios Chassis 260/250L and the operation playing a vital role is draw operation as found by analysis and logics.Hence we shall refer these as following:

Inframe :

In this section the defective parts and all processes responsible for the defect are covered.

Parts: All parts of chassis 360 L having crack.

Process: Draw operation

Outframe

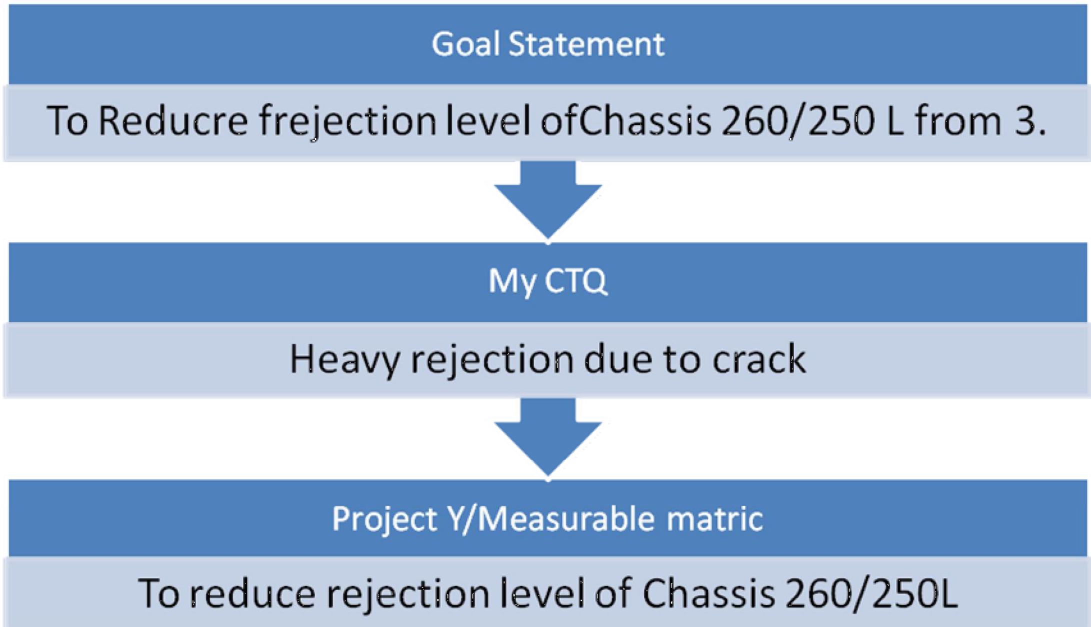
The processes that are not responsible for the defect are kept under this sectionAs in the present case all processes which are other than draw operation such as bending,trimming etc. Define Phase ends with the above Analysis.Now we shall lead to Measure Phase.

4.3 Measure:

First of all we should know about CTQ.

4.3.1 CTQ

A **CTQ tree** (Critical to Quality tree) is used to decompose broad customer requirements into more easily quantified requirements. CTQs are derived from customer needs. Customer delight may be an add-on while deriving Critical To Quality parameters. For cost considerations one may remain focused to customer needs at the initial stage.CTQs (Critical to Quality) are the key measurable characteristics of a product or process whose performance standards or specification limits must be met in order to satisfy the customer. They align improvement or design efforts with customer requirements.CTQs represent the product or service characteristics that are defined by the customer (internal or external). They may include the upper and lower specification limits or any other factors related to the product or service. A CTQ usually must be interpreted from a qualitative customer statement to an actionable, quantitative business specification.For the Existing project we can draw the CTQ tree as following:



Then we Have to choose the project Y that is to reduce rejection level in the present project.Data which we shall use are discrete.Then we have to define the defect which is crack in the component in the present project.Our unit is concerned with every lot and we shall try to find the opportunity in each one of the component.

Let's take 2 separate samples of 500 and 600 units respectively.Which are to be checked at the workplace that is the shop floor.Now we have to do the Measurement System Analysis.

4.3.2 MSA(Measurement System Analysis)

A **Measurement System Analysis** (**MSA**) is a specially designed experiment that seeks to identify the components of variation in the measurement.

Just as processes that produce a product may vary, the process of obtaining measurements and data may have variation and produce defects. A Measurement Systems Analysis evaluates the test method, measuring instruments, and the entire process of obtaining measurements to ensure the integrity of data used for analysis (usually quality analysis) and to understand the implications of measurement error for decisions made about a product or process. MSA is an important element of Six Sigma methodology and of other quality management systems.

MSA analyzes the collection of equipment, operations, procedures, software and personnel that affects the assignment of a number to a measurement characteristic.

A Measurement Systems Analysis considers the following:

- § Selecting the correct measurement and approach
- § Assessing the measuring device
- § Assessing procedures & operators
- § Assessing any measurement interactions
- § Calculating the measurement uncertainty of individual measurement devices and/or measurement systems

Now we shall inspect the defect visually for two operators as shown in the table on the next page.

Measurement System Analysis(MSA):

Measurement System: Visual

Operators: Ravi kr., Harbeer Kr.

Date of Analysis: 17 Jan 2010

Part No.	Part Description	Operator 1(Ravi Kr.)	Operator 2(Harbeer Kr.)
1	Chassis 260 L	NG	NG
2	Chassis 260 L	Ok	Ok
3	Chassis 260 L	NG	NG
4	Chassis 260 L	NG	NG
5	Chassis 260 L	NG	NG
6	Chassis 260 L	Ok	Ok
7	Chassis 260 L	NG	NG

Table 4.1

We have recorded the quantity of components produced and quantity rejected from DEC'09 to JUL'09. We prepare the work sheets as on the next page:

S/N	Month	Product Name	Qty. Produced	Qty. Rejected
1	Dec-09	cha. 260 l	10450	447
2	Nov-09	cha. 260 l	10825	182
3	Oct-09	cha. 260 l	7750	301
4	Sep-09	cha. 260 l	8289	402
5	Aug-09	cha. 260 l	9578	282
6	Jul-09	cha. 260 l	10048	150
Total			**56940**	**1764**

Table 4.2

From the above recordings we find out that the percentage repeatability and reproducibility is more than 90% and hebnce MSA is ok and we can proceed.

Now we shall calculate the **DPMO** for current and target conditions.

4.3.3 DPMO

In process improvement efforts, defects per million opportunities or DPMO (or nonconformities per million opportunities (NPMO)) is a measure of process performance. It is defined as

$$DPMO = \frac{1,000,000 \times \text{number of defects}}{\text{number of units} \times \text{number of opportunities per unit}}$$

A defect is defined as a nonconformance of a quality characteristic (e.g., strength, width, response time) to its specification. DPMO is stated in opportunities per million units for convenience: Processes that are considered highly-capable (e.g., processes of Six

Sigma quality) are those that experience only a handful of defects per million units produced (or services provided).

Note that DPMO differs from reporting defective parts per million (PPM) in that it comprehends the possibility that a unit under inspection may be found to have multiple defects of the same type or may have multiple types of defects. Identifying specific opportunities for defects (and therefore how to count and categorize defects) is an art, but generally organizations consider the following when defining the number of opportunities per unit:

- Knowledge of the process under study
- Industry standards
- When studying multiple types of defects, knowledge of the relative importance of each defect type in determining customer satisfaction
- The time, effort, and cost to count and categorize defects in process output

Other measures of process performance include:

- Process capability indices such as C_{pk}
- Natural tolerance limit or sigma level
- PPM defective
- Process performance indices such as P_{pk}
- Quality costs or cost of poor quality (COPQ)

4.3.4 COPQ

Now what is **COPQ**

Cost of poor quality (**COPQ**) or **poor quality costs** (**PQC**), are defined as costs that would disappear if systems, processes, and products were perfect.

COPQ was popularized by IBM quality expert H. James Harrington in his 1987 book *Poor Quality Costs*. COPQ is a refinement of the concept of quality costs. In the 1960s, IBM undertook an effort to study its own quality costs and tailored the concept for its own use. While Feigenbaum's term "quality costs" is technically accurate, it's easy for the uninitiated to jump to the conclusion that better quality products cost more to produce. Harrington adopted the name "poor quality costs" to emphasize the belief that investment in detection and prevention of product failures is more than offset by the savings in reductions in product failures.It is actually that cost that we have to bear for our fault or defect anyhow or in any way.

Thus now,

DPMO=(1000000*1764)/(56940*1)

DPMO=30980

Now,

For the current condition.

Production plan of the product annually=2400000 pcs.

Total rejection in an year=7632 pcs.

Rejection cost@Rs.69.37 per pcs.=7632*69.37

=Rs. 529431

Our consumable cost@0.65/kg= Rs. 2901

Total COPQ=529431+2901

=Rs.532332/year

Present sigma level=3.36

And similarly for the target condition,

DPMO=3098

Total uncontrolled rejection=2400pcs.

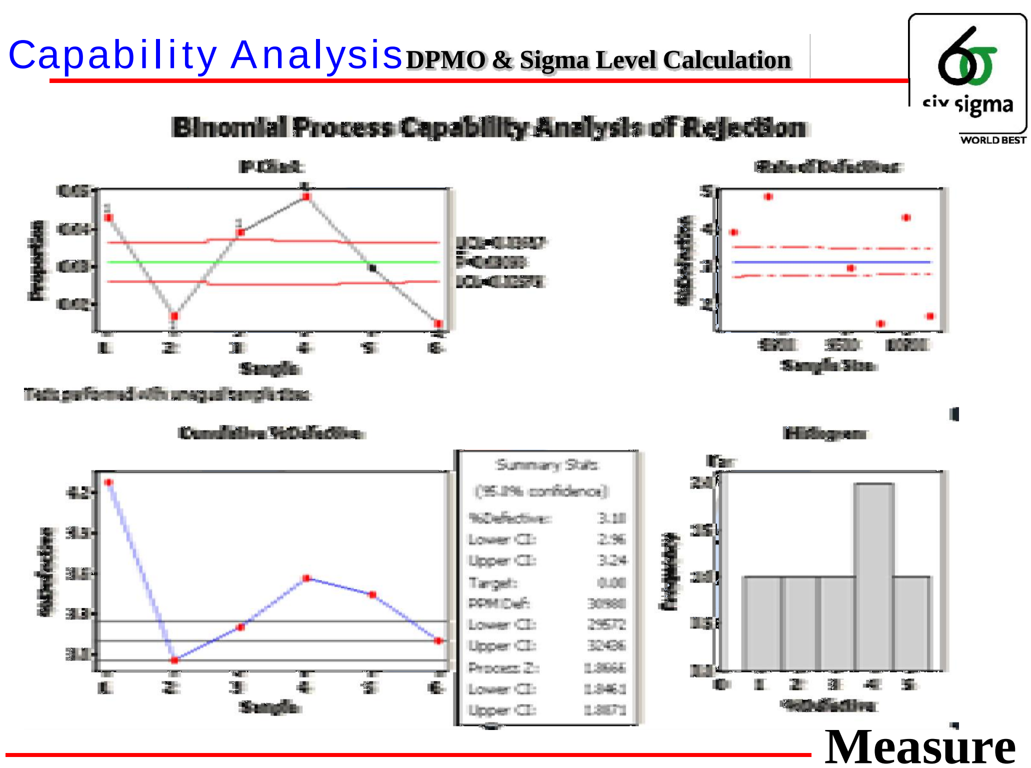
Rejection cost=Rs. 166488

Consumable cost= Rs. 967

Total COPQ=Rs. 167455

Required sigma level=4.23

Process capability analysis is shown as following for the calculated status:



Graph 4.1(Capability Analysis)

Now we have to find the potential X's which are expected to be the major reasons for the defect.By going thru the analysis we find the following potential X's for the current project:

1.Tool Cylinder gas

2.Sheet thickness

3.clearence between bush and punch of the die

4.Quality of polythene being used for the lubrication

5.Draw lubricant

6.Stroke length

7.Placement of sheet that is our raw material

8.Manpower skills

9.Material hardness

4.3.5 FDM Analysis

Customer priority rank	9	9	8	On quality basis
Key Process Input Variable	Improve quality	Customer satisfation	productivity	Rank
N2 gas improper in cylinder	9	8	5	81
Clearance b/w die & punch is more	8	8	2	72
Stroke length less or high	7	5	1	63
Variation in sheet thickness	7	9	4	63

Material hardness not ok	9	8	3	81
Improper placement of sheets	6	8	3	54
Draw lubricant not properly used	9	9	5	81
Quality of polythene not ok	8	7	4	72
Manpower skill	7	6	9	63

Table-4.3(FDM Analysis)

These all discrete data are collected on shop floor.

Analysis X1: Tool Cylinder Gas

Now we shall use the two proportion method.

To analyze the effect of tool cylinder gas on rejection of chassis component, we remove the cylinders from the draw tool & replace them to high tensile spring. Now we pick 500 samples and collected data of rejected pieces i.e. chassis 250/260 l in both the cases. Now we are doing 2- proportions method to see that tool cylinder gas effect on rejection of chassis component.

For sample size 500,

No. of springs,

With tool cylinder gas=22

With high tensile springs=5

Now,

P1=22/500=.044

P2=5/500=.011

Difference =p1-p2

=.044-.011=.034

95% CI for difference: (0.0140191, 0.0539809)

Test for difference = 0 (vs. not = 0): Z = 3.34 P-Value = 0.001

Fisher's exact test: P-Value = 0.001

Since the p value is 0.001 which is less then 0.05 we reject null hypothesis that means tool cylinder gas effect the rejection of chassis component. So we can say that this is vital X.

Analysis X2:_Raw material

To analyze the effect of Raw material on the rejection of chassis , we used the raw material of different supplier& then we pick 500 samples and then collected the rejection of chassis component i.e. chassis 250/260 l. Now we are doing 2-proportions method to see that whether the raw material of chassis effect the rejection of chassis component.

For a sample of 500 pcs. No. of defectives.

With Bhushan Steel=23

With ISPAT=40

Test and CI for Two Proportions

Sample	X	N	Sample p
1	23	500	0.046000
2	40	500	0.080000

Difference = p (1) - p (2)

Estimate for difference: -0.034

95% CI for difference: (-0.0640436, -0.00395637)

Test for difference = 0 (vs. not = 0): Z = -2.22 P-Value = 0.027

Fisher's exact test: P-Value = 0.037

Since the p value is 0.037 which is less then 0.05 we reject null hypothesis so we can say that raw material of chassis effect the rejection of chassis component. So we conclude that this is a vital X.

Analysis X3: Clearence between bush & punch

To analyze the effect of Clearance b/w bush & punch we collect 100 samples and collected the data of no. of rejection of chassis component after improving the clearance b/w bush & punch & before change the clearance b/w bush & punch . Now we are doing 2-proportions method to see weather the clearance b/w bush & punch effect the rejection of chassis component.

For samples of 500 pcs,

No. of defectives

Before i9mproving the clearance=15

After improving the clearance=5

Sample	X	N	Sample p
1	15	100	0.150000
2	5	100	0.050000

Difference = p (1) - p (2)

Estimate for difference: 0.1

95% CI for difference: (0.0180088, 0.181991)

Test for difference = 0 (vs. not = 0): Z = 2.39 P-Value = 0.017

Fisher's exact test: P-Value = 0.032

Since the p value is 0.032 which is less than 0.05 so we reject null hypothesis so we can say that clearance b/w bush & punch effect the rejection of chassis component. So w conclude that this is vital X.

Analysis X4: Quality of polythene

To analyze the effect of polythene quality on the rejection of chassis component we use the polythene of two different supplier & then pick 100 samples & then collected the rejection of chassis component. Now we are doing 2-proportions method to see that whether polythene quality effect the rejection of chassis component.

For the sample of 500 pcs,

No. of defectives,

With regular supplier=7

With local supplier=18

Sample	X	N	Sample p
1	18	100	0.180000
2	7	100	0.070000

Difference = p (1) - p (2)

Estimate for difference: 0.11

95% CI for difference: (0.0196076, 0.200392)

Test for difference = 0 (vs. not = 0): Z = 2.39 P-Value = 0.017

Fisher's exact test: P-Value = 0.031

Since the p value is 0.031 which is less than 0.05 so we reject null hypothesis so we can say that polythene quality effect the rejection of chassis component. So we can conclude that this is vital X.

Analysis X5: Stroke length

For a sample of 500 pcs,

No. of defectives,

With the same stroke lenth=9

After changing the stroke length=7

Sample X N Sample p

1 9 100 0.090000

2 7 100 0.070000

Difference = p (1) - p (2)

Estimate for difference: 0.02

95% CI for difference: (-0.0551462, 0.0951462)

Test for difference = 0 (vs. not = 0): Z = 0.52 P-Value = 0.602

Fisher's exact test: P-Value = 0.795

Since the p value is 0.795 which is greater than 0.05 so we fail to reject null hypothesis that means stroke length doesn’t effect the rejection of chassis component. So this is not vital X.

Analysis X6 : Placement of location pins

To analyze the effect of placement of location pins we collect 100 samples and collected the data of no. of rejection pieces i.e. chassis 250/260 l with some worn out location pins & actual location pins. Now we are doing 2- proportions method to see that whether this effect the rejection of chassis.

For a sample of 500 pcs,

No. of defectives,

For actual placement of location pins=

For worn out location pins=10

Sample X N Sample p

1 8 100 0.080000

2 10 100 0.100000

Difference = p (1) - p (2)

Estimate for difference: -0.02

95% CI for difference: (-0.0992756, 0.0592756)

Test for difference = 0 (vs. not = 0): Z = -0.49 P-Value = 0.621

Fisher's exact test: P-Value = 0.806

Since the p value is 0.806 which is greater than 0.05 so we fail to reject null hypothesis that means location pins doesn't effect the rejection of chassis component. So this is not vital x.

Analysis X7: Placement of Sheet

To analyze the effect of placement of sheet on the rejection of chassis component we collect 100 samples & collect the no. of rejection pieces i.e. chassis 250/260 l with some dislocation of sheet & with actual location of sheet. Now we are doing 2-proportions method to see weather this effect the rejection of chassis.

For the sample of 500 pcs. No. of defectives,

Actual location of sheet=9

After dislocation of sheet=11

Sample	X	N	Sample p
1	9	100	0.090000
2	11	100	0.110000

Difference = p (1) - p (2)

Estimate for difference: -0.02

95% CI for difference: (-0.103108, 0.0631080)

Test for difference = 0 (vs. not = 0): Z = -0.47 P-Value = 0.637

Fisher's exact test: P-Value = 0.814

Since the p value is 0.814 which is greater than 0.05 so we fail to reject null hypothesis that means placement of sheet effect doesn't effect the rejection of chassis component. So this is not vital X.

Analysis X8: Draw lubricant

To analysis the effect of draw lubricant on rejection of chassis component we take the expert opinion because we are using polythene in our process instead of draw lubricant.

By using of draw lubricant we analyzed that though the crack reduces but there is a deposition of

thin layer of lubricant which remains on the part which effects the nut welding process. and also a cleaning process has to be implemented to remove the layer. Increase of manpower and the process.

So instead of using draw lubricant we are using polythene in our process.

According to the expert opinion we can say that draw lubricant is not vital X.

Now on the basis of above analysis we find the list of vital X's as following:

Si. No.	Vital X's
1.	Tool Cylinder gas
2.	Raw material
3.	Clearance b/w bush & punch
4.	Polythene quality

4.4 Improve:

In these phase we shall take the improvement plans for the vital X's found in_analysis phase.We shall consider them one by one as following:

4.4.1 Vital X's We shall consider all the vital X's as per following

1.Tool cylinder gas :

Due to tool cylinder an uneven pressure is exerted on the component which tends to crack developed in the component. Because gas pressure is not equal in all the cylinders.The cylinder is shown in the following figure

Fig 4.1(Tool Cylinders in Die)

Now we shall replace the tool cylinders by high tensile spring.Problem of uneven pressure is solved by using the springs in place of cylinders. By using the springs the rejection level of chassis has been reduced.

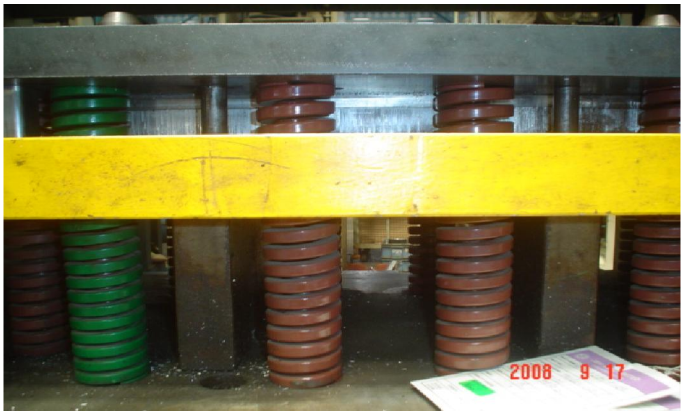


Fig 4.2(High Tensile Springs in Die)

2.Raw material:

Initially hardness of the material used for the component was 56 HRB causing high extent of crack.Later we replaced the existing material with a material having hardness 52 HRB.As a result the crack was reduced by a considerable extent.

3.Clearance between die and punch:

Earlier the clearance b/w die & punch had become non uniform due to regular wear & tear of punch causing the crack development in the component.Sometimes it happens when the die is being used for a long time without taking preventive actions.The wear & tear of the tool takes place which leads to many defects in production like crack in the present case.

We reduced the clearance between die and punch by spotting the die and also removed the high points.after that we polished the die as well as punch due to which crack was reduced by a considerable amount.

4.Quality of Polythene:

Initially we were using the polythene which was having high hardness and Thickness due to which the clearance between did and punch was being reduced.

Later we replacedkich ness due to whit by different polythene having less hardness as well as thickness due to which crack was reduced to a sensible amount.

Hence by taking the alternative actions for all the vital X's we reduced the crack in the product upto a reasonable amount.

Improvement Summary

This is shown in tabular form below :

Sr. No.	**Date**	**Produced Qty**	**Crack**	**Blank Cut**	**% of rej due to crack**	**Other % of Rej (blank cut)**	**Total Rej%**
1	01/03/10	1100	2	16	0.18	1.45	1.64
2	03/03/10	1550	5		0.32	0	0.32
3	04/03/10	425	5		1.18	0	1.18
4	05/03/10	900		8	0	0.89	0.89
5	07/03/10	1850		3	0	0.16	0.16
6	09/03/10	1800	1		0.06	0	0.06
9	11/03/10	1983			0	0	0
10	13/03/10	1416			0	0	0
11	14/03/10	1800		1	0	0.06	0.06
12	15/03/10	900	1		0.11	0	0.11
13	16/03/10	1850	1	1	0.05	0.05	0.11
14	17/03/10	1155			0	2	2
15	18/03/10	1700			0	2	2

16	21/03/10	1175			0	0	0
17	22/03/10	880	2		0.23	3	3.23
18	23/03/10	1230			0	0	0
19	24/03/10	1093	1		0.09	0	0.09
20	26/03/10	2190		4	0	0.18	0.18
21	27/03/10	2020	2	2	0.1	0.1	0.2
	Total	27017	20	35	0.07	0.13	0.2

Table-4.4(Improvement Summary)

4.5 Control:

This phase defines control plans specifying process monitoring and corrective actions. It ensures that the new process conditions are documented and monitored. All possible causes of specific identified problems from the analysis phase were tackled in the control phase. Control solutions to identified problems have been prepared in sequence to improve the solutions as explained above. This will prevent the problems from recurring.

In this phase we have to ensure that all the processes and the corrective action plans are done as per predefined project schedule. The plans have been implemented properly as defined and all the respective work is done within the specified time limit. The proposed control solutions to improve the previous solutions are listed in sequence as follows.

Firstly we should have the improvement summary as following:

Sn	Project Y	Vital X	Improvement Strategy	Improvement Done		Trail Run Date and Status	Implementation date
				Before Method	Current Method		
1	To reduce the rejection level of Chassis component.	Tool cylinder gas	Alternative	Tool Cylinders were used for pressing	Tool Cylinders are replaced by high tensile springs	Trail run done on 17/06/2008 and was done successful.	Implemented
2		Raw material	Alternative	Initially material of hardness 56HRB was used	Older material is replaced by material having hardness 51 HRB	Trail run done on 25/06/08 and was done successful.	Implemented
3		Clearence b/w die & punch	Alternative	Earlier clearance was non uniform b/w die & punch due to wear & tear of punch	Now die was spotting after 10,000 strokes which maintain a uniform clearance.	Trail run done on 02/07/08 and was done successful.	Implemented
4		Polythene quality	Alternative	Initially we used polythene of high thickness as well as high hardness	Later we usedpolythene of lesser hardness as well as low thickness	Trail Run done on 09/7/2008 and was Successful	Implemented

Table-4.5(Improvement Summary for Control Phase)

After it we shall create control chart with the help of control points defined as per following:

SN	Control Points	Specifications	Measurement Unit	Measurement/ Evaluation method	Measurement / Evaluation cycle		Who will do?	Recording method	Rea Plan
					Frequency	Sample			
1	Springs in the tool.	Springs	Visual	Visual check	Every run	-	Prod.Engr & quality engineer	Check Sheet	Spri will repl
2	Raw Material	Hardness	HRB	Hardness check with m/c	Every lot	5 Pcs	Quality Engg.	Check sheet	Reje the issu anot pack

3	Clearance b/w die & punch	Die will be spotting after 10,000 strokes	Strokes	Data check with Die History card	Every 10,000 Strokes	-	ProductionEngg./Tool room Engg.	Die History card	M/c stop give to roor spot

Table-4.6(Control Chart)

Then we shall have a coparison between target and achieved objectives as per following:

Target

Project Y: Reduce Rejection

DPMO: 3098

Sigma Level: 4.23

COPQ: 167455

Achieved

Project Y: Reduce Rejection

DPMO: 2036

Sigma Level: 4.37

COPQ: 33489

And we ensured that our project has been completed within the following time limits

Phase	Schedule	
	From	To
DEFINE	1 Jan 2010	14 Jan 2010
MEASURE	14 Jan 2010	29 Jan 2010
ANALYZE	13 Feb 2010	28 Feb 2010
IMPROVE	28 Feb 2010	13 Mar 2010
CONTROL	13 Mar 2010	

Table-4.7(Phase Schedule Summary)

In this way we ensured that the project has been done correctly within the specified time limits and by properly taking care of all the check points and we achieved the target upto a great extent and reduced the rejection level of Chassis 260 L significantly.

CHAPTER-5

Result Analysis And Discussions

5.1 Effect on DPMO:

Initially our DPMO was 30980.And when we applied the six sigma tools it got reduced to 2036.That means we have achieved a great reduction in the rejection level and en reasonable increase in productivity as well.

5.2 Effect on sigma level:

Initially when the problem of crack was arising heavily the sigma level was 3.36.But when we applied the six sigma tools it increased to 4.37.This is a good increase in Sigma level which itself indicates towards the improving quality and reduced rejection.

5.3 Effect on COPQ:

Initially the cost of poor quality was Rs.532332 per years which leads to A great loss but later on after the application of six sigma tools it reduced upto Rs.33489.Which saved a lost amount of cost and turned into high profits.

Hence it is clear that in the present project we find that if six sigma tools are implemented systematically then a great amount of reduction in present defect takes place. Due to which our effective production time is saved and similarly cost is reduced. As we see our cost of poor quality Is reduced from Rs. 532332 Rs. 33849.So we can say if we apply six sigma tools anywhere in production the quality is improved upto a reasonable level as in the present case No. of parts having Crack reduced.And the respective poor quality costs are also reduced. We have increased the profit of company by Rs. 64 lacs per annum.In this way we find that the Six Sigma philosophy not only improves the quality of the product but also raises the production profit upto a great extent.

CHAPTER-6

Conclusion And Future Scope

From the results of present project it is clear that as the Sigma level for the crack of product(Chassis 260 L) is increased,the Cost of Poor Quality reduced itself.Thus Six Sigma reduced the rejection level as well as Cost of Poor Quality.The quality improved as a result.This shows a less costlier product with better quality.Hence it can be said that by application of Six Sigma we move towards the improvement which may be at any stage or at any level.It is not only a method of reducing costs like many other methods,it takes quality at priority level.Six Sigma focuses more on external customers along with internal customer,Which is clear from the fact that it prefers quality over other factors.But one thing is clear that whenever it is applied to any problem or defect,it will provide an improvement.

With the help of present work done in this project it is clear that Six Sigma is a positive approach to make breakthrough improvement by involving managers at all levels in any organization. However, it is not magic which will happen by hiring any good trainer, black belt or consultant. It requires good vision of the executives and management, appropriate strategies based on experiences, practical and hands on training to managers that actually takes them through the use of advance statistical tools using the DMAIC processes; effective coordination through proper project management; and leadership of quality which demands effective accountability, motivation and teamwork from managers. Any initiative in the right direction with the right approach and right tools is a guarantee for success.

While working for the present project many advantages of Six Sigma has been learned. Some other work which is beyond the scope of this project,is suggested which is listed as below:

- Separate Approaches of quality can be applied to solve the same problem.TQM can be applied and after that the results of Six Sigma and TQM can be compared on both,quality as well as profit basis.
- Kaizen can be applied for the same problem or any other problems and the results may be compared to know the better one.
- Besides Manufacturing industry Six Sigma can be applied to many other places like Educational system for improving the results and quality of students.

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