Six Sigma Methodology: How To Use A Dmaic Process For Improving Quality: Review

[1] N. M. Chodvadia., [2] K. P. Hirpara

[1] *PG Student, School of Engineering, RK University, Rajkot, Gujarat, India.*

[2] *Assistant Professor, School of Engineering, RK University, Rajkot, Gujarat, India.*

Abstract:-

A Six sigma concept is basically useful to achieve the zero defects, in all functional areas of the organization. In this paper various research articles has been referred which gives the basic idea of tools of DMAIC process and also give the idea about how to use the DMAIC process's tools for reducing the quality of any industry. Considering all steps of DMAIC methodology is decided for the implementation of six sigma concept in the bearing manufacturing industry.

Keywords: -
Six sigma, DMAIC, Quality Improvement

1. Introduction

1.1. The development of quality engineering.

An important question that Company Managers are asking themselves is "How do we become successful?", but a question of equal importance is "How do we stay successful in the future?"**[1]**

A company cannot survive without customers. It is therefore very important that the company provides products that the customers are willing to pay for. In plain language this means that the ultimate goal for the company is to create value to the customer. Hence, the customer settles the quality of a product**.[2]**

The word quality has its origin from the Latin word "qualities", which means "character" There are several different definitions of the Quality Concept and many different opinions of what should be included in the concept of product quality. The authors have fallen for a definition of the quality of a product **[3]**

"The quality of a product is its ability to satisfy and preferably exceed the needs and expectations of the customers ". **[3]** (p.24)

In the more recent history of the quality development, the quality improvement Program Six Sigma has been successful. The American company Motorola developed Six Sigma as a consequence of poor quality and customer complaints, which affected the competitive power of the company negatively.**[4]**

The goal of Six Sigma is to substantially reduce unwanted variation that either results in cost reductions or increased customer satisfaction. The reduced variation may also lead to improved delivery performance and increased process yield.**[3]**

1.2 Six Sigma

Definition of Six Sigma as follows:

"A comprehensive and flexible system for achieving, sustaining and maximizing business success. Six Sigma is uniquely driven by close understanding and customer needs, disciplined use of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business process"**[5]** (p.11)

According to Pande mean that Six Sigma aims at a statistically calculated process target of 3.4 defects per million opportunities, dpmo.

Companies traditionally have accepted that their processes perform at a level of three to four sigma, which translates to 6,200 to 67,000 defects per million opportunity. [**2]**

1.2.1 The DMAIC improvement cycle.

Many different improvement models have been applied to processes over the years. Most of the models are based on the steps in the Plan-Do-Check-Act cycle, PDCA cycle, introduced by W. E. Deming **[5]**

Like many other models the DMAIC cycle is grounded in the original PDCA cycle. The main steps in the Six Sigma methodology, or DMAIC, are illustrated in Figure 1, The acronym should be interpreted as Define, Measure, Analyze, Improve and Control, which are symbols for the different phases in a Six Sigma project.

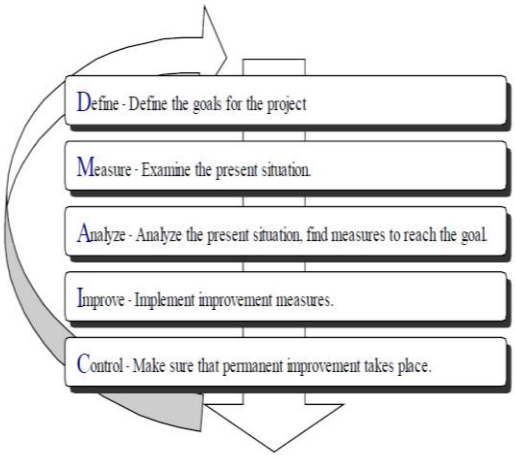

Figure 1The DMAIC methodology.**[2]** (p.4.).

Six sigma presents some solutions for eliminating these defects and improves the process capability to achieve a business excellence and a competitive edge. Nowadays six sigma has been considered as the most applicable and useful approach to improve the quality of products and services and also reaching a business excellence and more competitive advantage by eliminating wastes **[6]**

At first glance, the six sigma looks ever, leading organizations with a track record in quality have adopted six sigma and claimed that it has transformed their organizations with a track record in quality have adopted six sigma**.[7]**

DMAIC approach is the most applicable procedure for implementing six sigma includes five major phases.

1. Define: At this phase, after identifying potential projects and selecting best one(s), by constructing a decision team, an organization tries to implement those projects.
2. Measure: This phase includes the of Current process capabilities and identifies the most important parameters of goods and services.
3. Analyze: In this phase, organization tries to collect and analyze the past and current data to identify the relations and the reasons of defects and variations in process and products characteristics.
4. Improve: In this phase, based on the previous data, we propose some solutions and remedies to overcome the wastes. Also we should prove the effectiveness and efficiency of these solutions and implement them.

5. Control: And finally, decision team sets some standards and provides feedbacks to sustain the improvements.**[8]**

2. LITERATURE SURVEY.

2.1 The Define Phase

The first step in the DMAIC improvement cycle is the Define Phase.

The DMAIC (define-measure-analyze-improve-control) methodology is the heart of Six Sigma. These are the Six Sigma steps for your improvement project. The starting point is obvious— Define. You will notice that this phase integrates everything we've talked about up to this point, because in the Define phase you'll confirm the preliminary decisions you made about the reasons for tackling the problem you identified and go into more detail about the purpose, objectives, and scope of your project. You'll also collect data on the process and your customers and identify the project results you want. In other words, by the end of this phase, you will have effectively defined your project. By now, you should have chosen your first project and you should be ready to begin moving into DMAIC.**[9]**

Let's approach Define systematically. The following outline delineates the steps in the Define process. This outline is not written in stone; you can modify and adapt it to your requirements. However, it is important that you don't eliminate any steps.

1. Identify the problems in your process.
2. Identify the process owner/sponsor.
3. Begin the project charter.
4. Assemble the project team.
5. Build a RACI chart.
6. Collect customer data.
7. Translate VOC into CTQs.
8. Develop problem statements.
9. Establish project metrics.
10. Focus on the vital few factors.
11. Identify necessary resources.
12. Create a project plan.
13. Conduct a Phase-Gate Review.**[9]**

This phase is important because it sets the foundation for a successful Six Sigma project by helping the user to answer four critical questions:

1. What is the actual problem to focus on?
2. What is the goal for the project?
3. Who is the customer to this process and what are the effects of the problem for the customer?
4. What is the process that is investigated?**[5]**

According to Pande et al. (2000 p.239) adds to this list by suggesting that a current state map, future state, deliverables and due dates could be appropria.ble elements of the Define Phase. **[2]** Pyzdek (2003 p.239) In the Define step, a Six sigma team refines its problem statement & goals, identifies the factors which are critical to quality. This also ensures the business goal, priorities & expectations. 3 major outputs from the define stage are;

Project Charter
Measurable customer Requirements
High level process Map.**[10]**

2.2 The Measure Phase.

The second step in the DMAIC cycle is the Measure Phase. According to Pyzdek (2003) this phase has the objective to measure the existing system or process and also to establish reliable and valid metrics to help steer towards the project goal defined in the Define Phase.

Further, Pande et al. (2000) mean that it is often difficult to decide what to measure. This because of the many options available and that it is often strenuous to collect data.

"Part of the art of Six Sigma is to base decisions and solutions on enough facts to be efficient and to learn how to better use data over time"[5] (p.253)

Advocate the use of a simple mental X-Y model, where Y stands for the output and x the input factors, in all improvement projects. It is important to identify one or more characteristics, denoted Y or Ys, to get a focus in the project. Often only one Y is studied to lower the risk of a lost focus in the project. For each identified Y a number of Xs, that might influence the Ys, have to be identified. In reality there are two types of Xs, control factors and noise factors. Control factors can be physically controlled, while noise factors are considered uncontrollable, too costly or not desirable to control**.[11]**

To identify the Xs, Cause-and-Effect tools are often used, for example the Ishikawa Diagram. It is usually good to detect as many Xs as possible from the start and then select the ones to be studied closer

Now that you understand the basics of validation, we can outline the steps required in the Measure phase:

1. Select product or process CTQ characteristics; e.g., CTQ Y's.
2. Define performance standards for Y's.
3. Identify X's.
4. Validate the measurement system for Y's and Xs.
5. Collect new data.
6. Establish process capability (sigma level) for Creating Y. Conduct a phase-gate review. **[9]**

Measurement process was done as per the Phases predesigned; a proper Performa was developed for each phase to collect the valid data with the reasons. Here the DCP (data collection plan) was made.

Steps 1 and 3: Select Y's and Identify X's

Six sigma will start by discussing Steps 1 and 3 at once. Why? Because the Y's depend on the X's. So it makes sense to talk about identifying the focus

Y's and identifying the X's that drive them. Then we'll discuss defining performance standards for those Y's. You might recall from Chapter 2 the concept of the Y's and X's in the Six Sigma representation of the problem. These Y's are the key characteristics of the process you're trying to understand and improve or the problem you are trying to solve. The Y's are dependent variables because they depend on X's, which are independent variables. Remember the transfer function: Y = F (X). If we change that X, we can change that Y. The end goal for the Measure phase is to start understanding all of the potential X's that are affecting your processes and how well they perform—the Y's that result. Profit for your business is a Y, a variable that is totally dependent on many X's, such as advertising, product quality and availability, service, cost controls, resource utilization, and so on. To change your Y, we need to change one or more of those X's. The Y's that the grocery store was targeting for a Six Sigma improvement were total sales per hour (TS/hr), total items per hour (TI/hr), and correct total sales on every basket of items sold. The next step is to identify the X' s on which those Y's depend. Don't assume that you know the X's! I spoke with someone about the grocery store example and the Y of TS/hr and this person stated, "This is a silly measurement because every-one knows that this measurement only depends on the number of people coming into the store."

Wrong! Yes, that's one of the X' s, but the major X's that stood out were the number of cashiers available, the speed of the cashiers, the prices being correct, the availability of stockers, the status of equipment (working or broken), the availability of managers for approval, special promotions, and the stocking of items on the shelves. So, if you assume that total sales per hour depend only on the number of people who come into your store, you do not maximize your potential. The lesson: never assume knowledge.

Step 2: Define Performance

Standards for Y's As you look at your processes and identify the key outputs (Y's that should relate to the CTQs) and drivers or inputs (X's), you also need to think about what level of performance you want to achieve for both, but especially the Y' s. For the grocery store, the goal might be to have no more than one inaccurate receipt for every 100 or every 1,000. The bank loan staff might want to set a goal of rejecting no loans that should be accepted.

Step 4: Validate the Measurement

System for Y's and X's this step should feel familiar to you; it's how we started this chapter. This is measurement system analysis. In simple terms, you do whatever it takes to make sure that your system of measurement produces data on your Y's and X's that is valid. The results must be:

• **Accurate** —true or correct

• **Precise** —sufficiently specific

• **Repeatable** —the same when the same person uses the measurement system two or more times on a given item

• **Reproducible** —the same when two or more people use the measurement system on a given item

How you validate the measurement system depends, of course, on the system and on the Y's and X's. The examples earlier in this chapter showed in simple terms how a grocery store and a bank worked to validate their measurement systems. The process isn't complicated, but it must be logical. Focus on these two questions:

• What things do you need to measure?

• How do you need to measure those things to get information that will allow you to evaluate your measurement system and ensure that it will produce results that you can use?

Step 5: Collect New Data

Have you ever done any painting in your house or taught a class? If so, you know that the prep work takes at least three or four times the effort of the actual execution. Data collection is often like that; but it's the planning and prep that ensure that the data you'll be collecting will be useful. You've identified the Y's and X's for which you want to collect data and you've used the guidelines given at the start of this chapter to validate your measurement system.

Now it's time to collect data.

You should approach data collection as logically as you've approached improvement.

• Define clearly what will be measured.

• Decide how much data you need. Typically, you want a minimum of 30 measurements; in some cases you may need a lot more. This is something your Black Belts will learn about in their training.

• Develop forms and procedures for collecting the data.

• Establish the sample size. Use the rule of thumb from Chapter 6. More data is better. A simple rule is more than 30. There are more complex and mathematical techniques, but this will serve as a guideline.

• Develop the sampling plan. It must ensure capturing most of the possible events that can occur over time. Production, sales, and other activities show variations throughout a day, a week, or a month.

• Train all data collectors in the procedures.

• Test out the procedures and make any refinements. Make sure you're getting measurements that are valid—accurate, precise, repeatable, and reproducible.

• Collect the data.

Step 6. Establish Process Capability for Creating Y

Process capability is the ability of a stable process to achieve certain results. It is a statistical measure of inherent variation.

There are two methods for evaluating process capability:
• Calculate a sigma level based on yield.
• Do a capability analysis.

Step 7: Conduct a Phase-Gate Review

At the end of the Measure phase, just as in the Define phase, the Black Belt should report to the executive leaders on the status of the project. This presentation is an opportunity for you to ask questions, make suggestions, address any problems, allocate additional resources, provide support, and show your commitment. The phase-gate review also ensures that the team stays focused and the project stays on track. **[9]**

2.3 The Analyze Phase.

The Analyze Phase of the DMAIC cycle is about becoming a process detective. The use of tools in this Phase depends a lot on the process and the problem at hand **[5]**(Pande et al., 2003).

If the use of improvement tools enables the identification of which of the input variables to a process affect the output, then it is relatively easy to come up with an improvement solution.**[11]**

There are two key sources of input to be able to determine the true cause of a problem**:**

- Data Analysis: The use of measures and data to reveal patterns or other factors about the problem.

- Process Analysis: A deeper investigation of the process to understand how work is being done, which may help to find inconsistencies and problem areas that contribute to the problem. It is these two strategies combined that produce the real power of Six Sigma.**[5]**

We can outline the steps required in the Measure phase:

1. Localize the problem.
2. State the relationship you are trying to establish.
3. Establish the hypothesis or the questions describing the problem.
4. Decide on appropriate techniques to prove your hypothesis.
5. Test the hypothesis using the data you collected in the Measure phase.
6. Analyze the results and reach conclusions.
7. Validate the hypothesis.
8. Conduct a phase-gate review.

2.4 The Improve Phase.

All the work in the Define, Measure and Analyze Phases will hopefully pay off in the Improve Phase. This phase is about the generation, selection and implementation of solutions to the defined problem.**[5]** argue that the Improve Phase is about being creative and to find ways to do things better, cheaper or faster.**[2]**

list four questions that drive the Improve Phase:

- Can we come up with actions or ideas that will address the root cause of the problem and help us achieve our goal?
- Are any of these actions and ideas workable potential solutions?
- Which is the most cost-effective solution?
- Can we test the chosen solution to ensure that it really works and then permanently implement it?

[5] (p.276)

You are now in the Improve phase. The project team is ready to test and implement solutions to improve the process. The Improve phase comes naturally to all of us. The key to the Improve phase is creating the relationship between the X's and the Y's that

You are trying to improve.

Here are the questions for the Improve phase:

1. What is the possible root cause of defects?
2. How can you prevent or eliminate these causes?
3. What changes in product, service, or process design are required to achieve your improvement goals? How do you know those changes will be effective?
4. What are your next steps toward achieving your Improvement targets?
5. Has Finance been involved in the project to fully understand the cost implications of your improvement plans?
6. Are you satisfied with the level of cooperation and support you are getting?
7. What other support actions or activities do you need to accelerate your progress?

Remember that the Improve phase is about good judgment and using data to derive solutions. I encourage you to come up with crazy radical ideas for solutions, but make sure you have the relationship of the Y's and X's (proof). Improving your ability to improve is one focus of the Improve phase.

Let's recap your project from the Measure phase. You know your key metrics and you know the data being collected is valid. The Analyze phase has created a set of qualified X's suspected of causing the defects. There are many more topics that could be covered here, but the heart of the Improve phase is question 3 above: What changes are you going to make and how do you know that they will be effective? Two common techniques used to answer the second part of that question are correlation analysis and experimentation (more specifically a technique called design of experiments).

Overview of the Improve Phase

Here are the basic steps in the Improve phase,

1. Define the problem.
2. Establish the experimental objective.
3. Select the variables and choose the levels for the input variables.
4. Select the experimental design.
5. Run the experiment and collect data.
6. Analyze the data.
7. Draw practical conclusions.
8. Replicate or validate the experimental results.**[9]**

The Control Phase.

The final phase of the DMAIC cycle is the Control Phase. This phase is about making sure that the made improvements last. This is often done by modifications of compensation and incentive systems, policies, procedures, budgets and other management systems. **[2]**

Once the solution has been implemented the process should be monitored to secure that the desired improvement targets have been achieved Results and experiences from the improvement project need to be shared throughout the organization.[**11]**

Pande et al. (2000 p.344) gives recommendations worth considering in the Control Phase:

- Develop good documentation to support the process.
- Create measurement reports to supply information quickly and simply.
- Develop plans to take care of problems that may arise in the future.
- Keep documents active so that they don't become obsolete.**[5]**

The Control phase ensures the new process conditions are documented and monitored via process control methods. After a settling-in period, the process capability should be reassessed. Depending upon the outcomes of such a follow-on analysis, it may be necessary to revisit one or more of the preceding phases. We'll emphasize SPC (statistical process control) and cover the simple methods only.

Here are the basic steps in the Control phase, using the standard steps for SPC, to serve as a guideline for working with control charts:

1. Select the variable to chart.
2. Select the type of control chart to use.
3. Determine rational subgroup size and sampling Interval/frequency.
4. Determine measurement methods and criteria.
5. Calculate the parameters of the control chart.
6. Develop a control plan.
7. Train the people and use the charts.
8. Conduct a phase-gate review.**[9]**

3. CONCLUSION.

In this paper, The detailed study is carried out about six sigma and how to use a DMAIC process. I also use the DMAIC process in my project, implementation of six sigma concept in bearing industry, use of above study.

Define phase

In define phase, Identify the problems in your process. Six sigma use the tools are Begin the project charter, Assemble the project team ,Collect customer data , Translate VOC into CTQs, Develop problem statements ,Establish project metrics, Focus on the vital few factors, Identify necessary resources, Create a project plan.

Measure phase.

In the measure the, Downtime in Production line, Frequency Study of defects, The Cause-and-Effect Diagram (also known as Ishikawa Diagram) was used in the Measure Phase to detect causes to the problems , Cost connected to the problem.

The Analyze Phase.

In Analyze phase six sigma using the tools of DMAIC, Process FMEA, Why-why analysis, Statistical Process Control.

The improvement phase.

In this phase DMAIC process is use to Define the problem, Establish the experimental objective, Select the variables and choose the levels for the input variables, Select the experimental design ,Run the experiment and collect data, Analyze the data, Draw practical conclusions, Replicate or validate the experimental results.

The control phase.

In control phase using tools of DMAIC process are Select the variable to chart, Select the type of control chart to use, Determine rational subgroup size and sampling Interval/frequency, Determine measurement methods and criteria, Calculate the parameters of the control chart, Develop a control plan, Train the people and use the charts.

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