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Elimination of rework in V Cap by Using Six Sigma Methodology

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Abstract:- The purpose of this project was to gain a strong understanding of Six Sigma management philosophy, concepts, and practices and to apply this knowledge to creating a Six Sigma academic course or training program. This was done through three main methods: preliminary research and data collection, the creation of a design model for Six Sigma academic course program establishment, and the creation of a Six Sigma academic course program syllabus. The preliminary research consisted of conducting a Six Sigma knowledge survey with the students of Worcester Polytechnic Institute, interviewing a Six Sigma expert, and examining current Six Sigma educational programs in other universities, businesses, and organizations. As a result of our observations, we determined that Six Sigma has become a large part of many companies and should be implemented into more engineering programs at universities nation-wide, including Worcester Polytechnic Institute. This can be done through a project based course, as well as more Six Sigma based Interactive and Major Qualifying Projects.

I. INTRODUCTION

Quality management has been an important management strategy for achieving competitive advantages and improvements. Traditional quality concepts like Statistical Quality Control1, Statistical Process Control, Zero Defects and Total Quality Management3, have been key players for many years; While Six Sigma is a more recent initiative quality improvement to gain popularity and acceptance in many industries across the world (Hendry and Nonthaleerak, 2005). The basic elements of Six Sigma like, Statistical Process Control, Failure Mode Effect Analysis4, Gage Repeatability and Reproducibility and other tools that have been on reduction of

1 - SQC
2 - SPC
3 - TQM
4 - FMEA

rejects and enhancing the quality. Six Sigma provides a framework in which all these tools can be performed with management support.

II. SIX SIGMA METHODOLOGY

1.1 Six sigma Definition

The six sigma define as business process that allows companies to drastically improve their bottom line by designing and monitoring everyday business activities in ways that minimize waste and resources while increasing customer satisfaction by some of its proponents.(Andersson, etal 2006).

The term "Six Sigma" refers to a statistical measure of defect rate within a system. supported by statistical techniques, it presents a structured and systematic approach to process improvement, aiming for a reduced defect rate of 3.4 defects for-ever million opportunities, or Six Sigma.(Pepper,Spedding,2010)

1.2 Six sigma Hiwstory and Overview

The six-sigma methodology was developed at Motorola in 1987 in response to sub-standard product quality traced in many cases to decisions made by engineers when designing component parts. Traditionally, design engineers used the "three-sigma" rule when evaluating whether or not an acceptable proportion of manufactured components would be supposed to meet tolerances. When a component's tolerances were consistent with a spread of six standard deviation units of process variation, about 99.7 percent of the components for a centered process would be expected to conform to tolerances. That is, only 0.3 percent of parts would be nonconforming to tolerances, which means that to3,000 defected parts per mil-lion (DPPM),(Arnheiter and Maleyeff,2005).

The six sigma started by Motorola was the first company to launch a six sigma approach in the mid-1980sIn 1988, where the Motorola specialized in electronic products, Bill Smith1986 is engineer and statistician at Motorola, introduce the six sigma concept aiming to attack the existing quality problems in the company.

Motorola received the Malcolm Baldrige National Quality Award, which led to an increased interest of six sigma in other organizations, see Pyzdek (2001). Today, a number of global organizations have developed six sigma approach of their own and six sigma is now established in almost every industry. (Andersson, etal 2006).

At Motorola, when studying the relationship between the quality of component and the quality of finalproduct it was discovered that, from lot-to-lot, a process tended to shift amaximum of 1.5 sigma units (McFadden, 1993). This concept is shown graphically in next Figure, which shows a centered process and processes, shifted 1.5 sigma units in bothdirections. Table provides the relationship between component quality and finalproduct quality, assuming that the full 1.5 sigma shift takes place. In next Table, Sigmalevel is the standardized process variation (see Figure), OFD quality is the NCPPM if the process shifts a full 1.5 sigma units, and the probabilities in the table provide the proportion of final products that will be free of defects. For example, if the company sets a goal for final product quality of 99.7 percent and products include about 1,000 OFDs, then the 3.4 DPPM corresponding to the Six-Sigma methodology would became the standard against which all decisions were made,(Arnheiter and Maleyeff,2005).

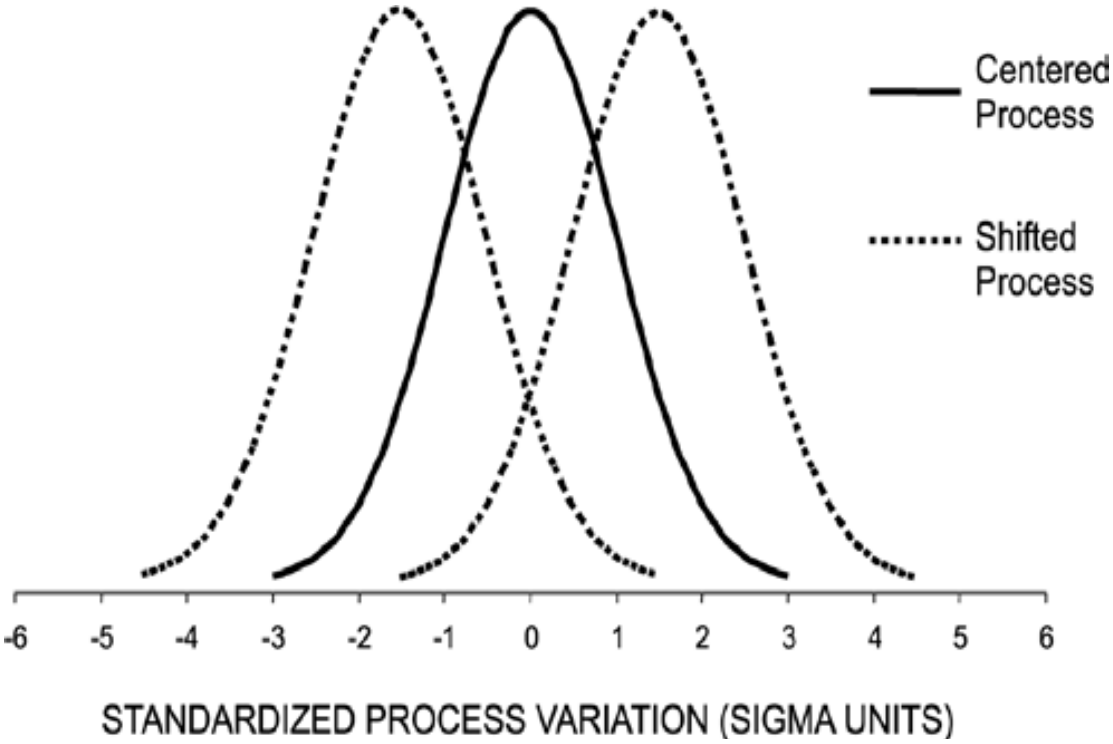

Fig.2 Process average shifting+/-1.5 Sigma units

Tab.1 Final product quality level (percentage conforming)

Six Sigma was started and developed at Motorola by an engineer Bill Smith in the mid-1980s.Six Sigma is credited with playing a major role in the turnaround Motorola accomplished in their quality at the time culminating in Motorola winning the 1988 Balding National Quality Award.(Snee, 2010)

Six sigma established the power implementation and Significant deployments lead by the chief executive officers (CEOs) at Allied Signal and general electric (GE) was the next major step for the approach. Welchpromoted Six Sigma aggressively inside and outside GE. The initiative established major usage across business and industry; first in the USA and then globally.Most would agree that the state of "process excellence" is the ultimate goal of Six Sigma improvement.(Snee, 2010)

1.3 Six sigma successful companies

There are two successful companies in implementing six sigma programs.

The first case is Volvo Cars in Sweden claims that the six sigma program hasdonated with over 55 million euro to the bottom line during 2000 and 2002. And, another company is the Business Unit of Transmission & Transportation Networks at Ericsson located in Bora°s, Sweden. Ericsson in Bora°s has about 1,100 employees. According to Peter Ha¨yha¨nen, a promoter and educator at Ericsson, they established their six sigma programme in 1997. At Ericsson, in the first six sigma was used as methodology for solving problems. Today, they rather see six sigma as a business excellence model for concrete areas and as a methodology in

order to reach business goals. At Ericsson in Bora°s, around 50 Black Belt projects and 200 Yellow Belt projects have been executed between 1997and 2004, with total savings of approximately 200-300 million euro between 1997 and 2003.(Andersson, etal 2006)

1.4 Six sigma objectives

The six sigma consider as continuous improvement tool and as continuous improvement process for reducing variation in process which meaning the defected products or defected service, which focuses on continuous and breakthrough provements. Improvement projects are driven in a wide range of areas and at different levels of complexity, in order to reduce variation. The main purpose of reducing variation on a product or a service is to satisfy customers. The goal of six sigma is that only 3.4 of a million customers should be unsatisfied and this is the six sigma target.(Andersson, etal 2006)

1.5 Six sigma Roadmap

There are two major improvement methodologies in six sigma, one for already existing processes and one for new processes. The first methodology used to improve an existing process can be divided into five phases and also we can callsix sigma roadmap. Which clarified in next points? (Andersson, etal 2006)

1. Define phase. In this phase we clarify the process or product that needs improvement. Define the most suitable team members to work with the improvement. Define the customers of the process which are the internal or external customers, their needs and requirements, and create a map of the process that should be improved.
2. Measure phase. Identify the key factors that have the most influence on the process, and decide upon how to measure them and in this phase we can collect fresh data to clarify the sources of process variation.
3. Analyze phase. Analyse the factors that need improvements and we can reduce the factors of process variation.
4. Improve phase. Design and implement the most effective solution. Cost-benefit analyses should be used to identify the best solution and hypothesis test to assure the improvement.
5. Control phase. Verify if the implementation was successful and ensure that the improvement sustains over time. So we can use control tools such as control plan. (Andersson, etal 2006)

Six Sigma brings structure to process improvement by providing the user with a more detailed outline of Deming's plan-do-check-act cycle by guiding the initiative through a five stage cycle of define-measure-analyze-improve-control (DMAIC); Each stage has a number of corresponding tools and techniques such as statistical process control, design of experiments and response surface methodology, providing the user with an extensive tool box of techniques, inorder to measure, analyze and improve critical processes in order to bring the system under control.(Pepper, Spedding ,2010)

By comparing these four simple but rigorous steps with Motorola's six steps tosix sigma quality it seems on the surface as if GE (or Jack Welch) in beginning of their six sigma journey focused only on Step 6 in Motorola's roadmap. Later on we-know that the sigma improvement process usually followed the so-called DMAIC process, which is defined as follows

- Define. Identification of the process or product that needs improvement and identify the voice of the customers.
- Measure. Identify those characteristics of the product or process that are critical to the customer's requirements for quality performance and which contribute to customer satisfaction, in this phase we can collect the fresh data.
- Analyze. Evaluate the current operation of the process to determine the potential sources of variation for critical performance parameters.
- Improve. Select those product or process characteristics which must be improved to achieve the goal. Implement improvements.
- Control. Ensure that the new process conditions are documented and monitored via statistical process control methods (SPC). Depending on the outcome it may become necessary to revisit one or more of the preceding phases (Dahlgaard, Park 2006),

The six sigma road map and applying a step-by-step process based road map is a key success factor (KSF) in implementing any six sigma project regardless of the size or type of the business.Also this clarifying in the next table.(Nabhani,Shokri2009)

Tab.2 Key steps of six sigma

Six sigma steps	Key processes
Define	Define the requirements and expectations of the customer Define the project boundaries Define the process by mapping the business flow
Measure	Measure the process to satisfy customer's needs Develop a data collection plan Collect and compare data to determine issues and shortfalls
Analyse	Analyse the causes of defects and sources of variation Determine the variations in the process Prioritise opportunities for future improvement
Improve	Improve the process to eliminate variations Develop creative alternatives and implement enhanced plan
Control	Control process variations to meet customer requirements Develop a strategy to monitor and control the improved process Implement the improvements of systems and structures

Source: Kwak and Anbari (2006)

1.6 Another six sigma roadmap (DMADV)

DMADV roadmapis often used when the existing process-es do not satisfy the external customers or isn't able to achieve strategic business objectives so we focused on design and verification phases, this methodology can also be divided into five phases; define measure, analyze, design, verify. (Andersson, etal 2006)

1.7 Six sigma Misconceptions

The Key misconceptions regarding six sigma in three points as below:

1- Six Sigma is that it is the new flavor, pushed by quality consultants in a way similar to the way Deming Management, TQM, business process reengineering (BPR), and ISO 9000 were pushed in the recent past. Unfortunately, there will always be consultants who jump onto any bandwagon, take a seminar and proclaim themselves experts in a program Six Sigma is no exception to this phenomenon.

2- Six Sigma is that the goal of 3.4 NCPPM is absolute and should be applied to every opportunity tolerance and specification, regardless of its ultimate importance in the customer's value expression. While the 3.4 NCPPM was derived at Motorola based on the characteristics of its products.

3- Six Sigma is that it is a quality only program. As described earlier, the concept of Six Sigma "quality" relates to the entire customer value equation.

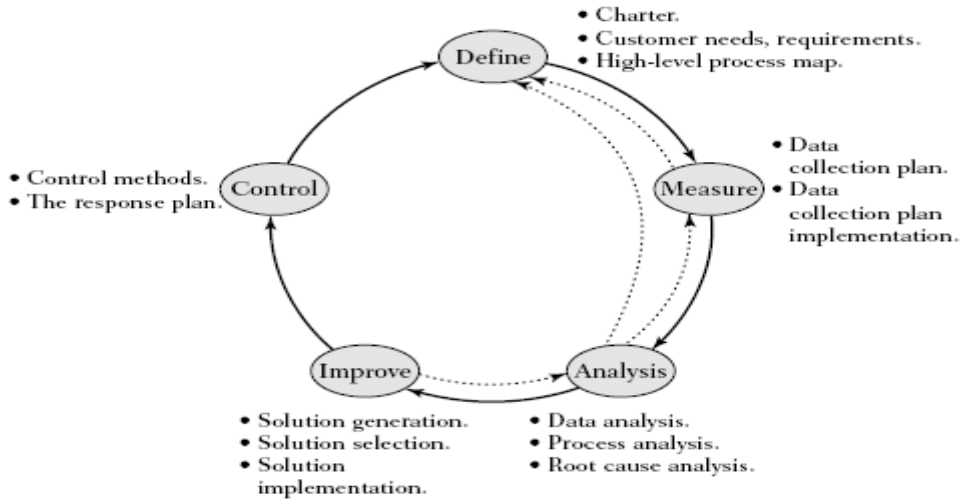

Fig.3 High-level DMAIC improvement methodologies.

1.8Criticism of six sigma

The six sigma has the same common features as TQM and that six sigma does not, in principle, contain anything new. In more detail, they state that six sigma is a highly disciplined, data-oriented, top-down approach, which typically includes four stages (measure, analyze, improve and control) and the use of statistical decision tools. The new thing concerning six sigma is the clear linking of the tactical and the strategic, For example,

statistical techniques are used in a systematic way to reduce variation and improve processes, and there is a strong-er focus on results, including customer needs.(Andersson, et al 2006)

There is a complexity in six sigmaapproach to exceed and achieved the customer's needs and hence increase the custom-er satisfaction. So to avoid this problem some companies use voice of the customer tools (VOC) in their define phase claim that six sigma approach fail to create conditions in order to involve everyone, which is more emphasized in the TQM.

TOTAL QUALITY MANAGEMENT (TQM)

2.1 TQM Definition

The TQM define as a continuously evolving management system consisting of values, methodologies and tools, the aim of which is to increase external and internal customer satisfac-tion with a reduced amount **4.2**

The main objectives of TQM, six sigma and lean

The effect and main objectives of TQM, six sigma and lean, the main objective with TQM is to increase the customer satisfaction, see Hellsten and Klefsjo¨ (2000). Eklo¨f etal. (1999) have also shown that there is a positive correlation between customer satisfaction and the financial results of companies. Moreover, it has been shown that organizations that have successfully implemented TQM outperform similar organizations regarding a number of financial indicators.(Andersson, etal 2006).

Six sigma, the projects are selected in such a way that they are closely tied to the business goals or objectives. The company's business goals are normally set in such a way that customers' needs will be satisfied. Before starting a six sigma project, one must prove that the improvement will result in economical savings for the company and we can study the business case, the six sigma does not necessarily improve customer satisfaction to the same extent as a successful TQM. The reason is that a six sigma primarily emphasizes the economical savings and secondly the customer satisfaction where the six sigma focused on the variation in the internal processes or internal failure which led to external failure (customers com-plaint). This view was supported by Ericsson in Bora°s. (Andersson, etal2006).

2.3 Criticism of TQM

TQM is, a number of failures of organizations trying to implement TQM have been documented. In more detail, a number of organizations have put a large amount of resources on implementing TQM, but with no tangible improvements achieved

2.4 Comparison between six sigma and TQM

Six Sigma is a broad long-term decision-making business strategy rather thana narrowly focused quality management program, (Arnheiter and Maleyeff, 2005)

Six Sigma is a combination of the Six-Sigma statistical metric and TQM, with additional innovations that improve the program's effectiveness while expanding its focus. The main components of Six Sigma maintained from TQM include a focus on the customer, recognition that quality is the responsibility of all employees, and the emphasis on employee training, (Arnheiter and Maleyeff, 2005).

Six-Sigma methodology is also used, but in an expanded fashion. With Six Sigma, the value of an organization's output includes not just quality, but availability, reliability, delivery performance, and after-market service. Performance within each of the components of the customer's value equation should be superior. Hence, the Six-Sigma methodology is implemented in a broad fashion, striving for near perfect performance at the lowest level of activity. In addition, Six Sigma programs generally create a structure under which training of employees is formalized and sustained to ensure its effectiveness. All employees involved in activities that impact custom-er satisfaction would be trained in basic problem solving skills. Other employee's are provided advanced training and required to act as mentors to others in support of quality improvement projects,(Arnheiter and Maleyeff,2005).

2.5 The comparison between six sigma and TQM

The process view and approach for the TQM, Six sigma and Lean the improvement projects in a six sigma methodology are conducted in a wide range of areas and at different levels of complexity in order to reduce variation, When the project members have reduced the variation in a process, and hence achieved the business goals, increased the profit or lowered the cost, this improvement is visualized to the top managers at the company. (Andersson, et al 2006).

Some of the top managers are also involved in the per-formed improvement projects. As a result, the six sigma approach receives necessary support from the top managers at the company, as the managers recognize

the economical impact of it. This could be one explanation for the documented successes of six sigma compared with TQM, i.e. six sigma approach Andersson, etal 2006).

2.6 Dissimilarities between six sigma, lean and TQM

Lean is a discipline that focuses on process speed and efficiency to decrease the process shift, or the flow, in order to increase the customer value; in lean manufacturing, project groups are usually the approach to perform the necessary improvements. While six sigma and lean focus on performing improvements mainly through projects to reduce the process variation, TQM has sometimes a different approach. TQM emphasizes the commitment and involvement of all employees.(Andersson, etal2006).

III. CONCLUSION

It is possible in this proposed research to anticipate the specific and general benefits likely to be achieved as a result of completion of it. Variable control charts are used to study a process when characteristics is a measurement, for example, cycle time, processing time, waiting time, highest, area, temperature, cost or revenue. Control charts detect special causes of variation, measures and monitors common causes of variation, know when to look for problems and adjust or when to keep hands off know when to make a fundamental change. The control limits obtained after the remedial actions taken lie within specification and the control limits.

The thicknesses of all the components obtained have been located very close to the process mean. As all these results are found positive, it may conclude that the process is under control. The process capability (Cp) is increased to considerable value showing that implementation of SPC technique is proved to be successful in improving the performance of a process thereby making it more capable of producing the products with right dimensions. Capability Ratio (CR) been reduced to lowest value meaning that the process spread occupy minimum of the tolerance. It is believed that the lower is the CR the more is capable the process.

These all conclusions become possible to understand with the successful implementation of an SPC technique. Since this work is done in a process industry as a whole, similar work may be done in other areas of industries country wide.

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