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Review of Six Sigma and CMM: Techniques for Quality Improvement

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Abstract -Quality improvement is important to industries as it can decrease defective products, reduce operation cost, and improve product quality. Quality improvement leads to increase in performance and decrease process variation which in turn helps in defect reduction and improvement in profit, employee morale and quality of a product. It helps in utilizing information and statistical analysis to measure and improve a company's operational performance, practices and systems by identifying and preventing defects in manufacturing and service related processes in order to anticipate and exceed expectations of all stakeholders to accomplish effectiveness.

Keywords— Quality Improvement , Six Sigma, CMM.

INTRODUCTION

In the present industrial scenario industries are fighting with the problems affecting their growth and development. Main aim of an industry is to provide goods and services to the consumers while making profits as well as satisfying the customers. Various tools and techniques have been adopted to overcome these problems, to increase the performance of an industry. Industrial process improvement depends on the characteristics of a system and this often involves building non linear models. This article is focusing on the measures used to improve the quality of an industry on the whole. Various techniques are available for industrial quality improvement such as:

* **Six Sigma:** Six sigma is a rigorous and systematic methodology that utilizes information and statistical analysis to measure and improve a company's operational performance.

* **CMM:** Capability maturity model developed by Software Engineering Institute. CMM provides guidance in specific process areas by providing goals and set of expected practices needed to meet these goals

* **CMMI:** Capability Maturity Model Integration. It helps integrate traditionally separate organizational functions, set process improvement goals and priorities, provide guidance for quality processes, and provide a point of reference for appraising current processes.

* **ISO:** International Organization For Standardization. ISO is an international standard setting body composed of representatives from various national standard organizations. This organization

promulgates worldwide proprietary industrial and commercial standards.

* **SAP:** Systems, Applications and Products in data processing. SAP is an enterprise resource planning (ERP) software product capable of integrating multiple business applications with each application representing a specific business area. These applications update and process transactions in real time mode. It has the ability to be configured to meet the needs of the business.

* **IEEE:** Institute of electrical and electronics engineers. The world's largest technical professional society -- promoting the development and application of electro-technology and allied sciences.

* **ANSI:** American National Standards Institute. ANSI publishes some software-related standards in conjunction with the IEEE.

From the above listed techniques of quality improvement, comparison between Six Sigma & CMM is the focus of this paper. This paper discusses about Six Sigma and CMM individually as well as the scope of using it together. Along with that few differences between the two techniques are highlighted.

SIX SIGMA

"The goal of Six Sigma is to increase profits by eliminating variability, defects and waste that undermine customer loyalty." (*IT service management: An Introduction, 2007, p416*) In simple words it is the latest tool used to improve the overall quality of an organization so as to satisfy the customers to the maximum. Six Sigma is a long term, forward-thinking initiative designed to fundamentally change the way corporations do business. (*System, software and services process improvement, 2010,*

p258) It is first and foremost “a business process” that enables companies to increase profits dramatically by streamlining operations, improving quality and eliminating defects or mistakes in everything a company does. Six Sigma is a broader tool for quality improvement of a company. It provides specific methods to re-create the process itself so that defects are never produced in the first place.

Though the concept of Six Sigma was introduced by Walter Shewhart in 1920's in the form of Three Sigma, but the credit for coining the term 'Six Sigma' goes to the Motorola engineer Bill Smith. Motorola says the data driven defect-reduction process has saved the company more than \$16 billion over the past 15 years.

Six Sigma increases performance and decreases process variation which ultimately leads to defect reduction and vast improvement in profits, employee morale and quality of a product. (*IT service management: An Introduction, 2007, p 416*) Six Sigma is a rigorous and systematic methodology that utilizes information and statistical analysis to measure and improve a company's operational performance, practices and systems by identifying and preventing defects in manufacturing and service related processes in order to anticipate and exceed expectations of all stakeholders to accomplish effectiveness. If the process sigma value increases from 0 to 6, the variation of the process around the mean value decreases. With high enough value of process sigma, the process approaches zero variation and is known as ZERO DEFECT. (*Principles of foundry technology, 5th edition, p350*) The process sigma value can be increased by decreasing the process variation which is the square of the process standard deviation.

Six Sigma is based on two approaches which are (*simulation-based lean six-sigma and design for six sigma, 2006, p15*):

- a. DMAIC: DMAIC refers to a data driven quality strategy for improving processes, and is an integral of the company's Six Sigma Quality Initiative. It is an acronym for five interconnected phase: Define, Measure, Analyze, Improve, and Control. Each step is individually important and perhaps ensures best possible results.

Define: Define phase includes defining the customer, his requirements for products and services and even his expectations. This phase even enlists the project boundaries and the major processes to be improved by mapping the process flow. Define phase defines CTQ's (critical to quality issues).

Measure: This phase develops a data collection plan for the process by collecting data from many sources to determine the types of defects in the process. It helps in measuring the performance of the core business process involved.

Analyze: It identifies the data collected and the process map to determine the root causes of the defects and opportunities for improvement by identifying gaps between the current performance and the goal performance. It prioritizes the opportunities which are to be improved.

Improve: This phase creates innovative solutions using technology and discipline to fix and prevent the problems thus improving the target process. It helps in developing and deploying the implementation plan.

Control: Control phase controls the improvements to keep the process on the new course and thereby preventing it to revert back to the “old way.”

- a. DFSS: Design for Six Sigma (DFSS), or the Six Sigma DMADV process (Define, Measure, Analyze, Design, Verify) is an improvement system used to develop new process or products at Six Sigma quality levels. It can also be employed if a current process requires more than just incremental improvement. DFSS focuses on every single CTQ (critical to quality) that matters to every customer, looks at products and services as well as the processes by which they are delivered, and aims to bring forth a new product or a service with the performance of about 4.5 sigma or even better.

CMM

The Capability Maturity Model (CMM) was developed by the Software Engineering Institute (SEI) at Carnegie-Mellon University (*successful software development, 2nd edition, p436*) to describe a framework of process maturity. The capability maturity model is a methodology used to develop and refine an organization's software development process. It describes an evolutionary improvement path from an ad-hoc, immature process to a mature, disciplined process. This model applies to new product development as well as software development.

The CMM defines five levels of process capability, each of which represents an evolutionary plateau towards a disciplined, measured and continuously improving software process. (*Software engineering project management, 2nd edition, p50*)

The Initial Level: At the Initial level (Level 1) few organized processes exist. Each developer utilizes whatever methods or techniques strike his or her fancy. The situation is sometimes described as chaotic and ad-hoc. At this level the software quality is more a matter of chance, and is highly dependent on the capabilities of specific individuals within the organization.

The Repeatable Level: To reach Level 2, a software development organization must put into place basic project management practices. This includes the capability to estimate the size of the software to be produced, estimate resources to execute the project, and track progress against these estimates. Also included is the implementation of software configuration management, quality assurance practices, the capability to effectively manage the requirements definition process, and the capability to manage subcontractors. This level is referred to as the Repeatable level; the organization has mastered tasks previously learned. The organization is still highly dependent on individuals for the success of a project. In times of stress, the organization tends to revert back to behaving as a Level 1 organization.

The Defined Level: At the defined level, the standard process for developing new products is

documented. These processes are based on integrated product development practices. Processes are used to help the managers, team leaders and development team members perform more effectively. Projects tailor the organization's baseline development process to develop their tailored process which accounts for the unique characteristics of the project. A well-defined process can be characterized as including readiness criteria, inputs, standards and procedures for performing the work, verification mechanisms (such as team reviews), outputs, and completion criteria. Roles and responsibilities are clearly defined and understood. Because the software process is well defined, management has good insight into technical progress on all projects. Project cost, schedule, requirements are under control and product quality is tracked.

The Managed Level: At Level 3 and below, the primary focus is on product quality. At the Managed Level and hence, the primary focus shifts to process quality. To reach the Managed level the organization focuses on establishing a set of process measures and uses them to initiate corrective actions. Once these measures have been established, the organization is ready to begin to use them to implement continuous process improvement.

The Optimizing Level: At the optimized level, the entire organization is focused on continuous process improvement. The organization has the means to identify weaknesses and strengthen the process proactively with the goal of preventing the occurrence of defects. Data on the effectiveness of the development process is used to perform cost benefit analyses of new development technologies and propose changes to the organization's development process. Innovations that exploit the best integrated product development practices are identified and transferred throughout the organization. Product development teams analyze failures and defects to determine their causes. Development processes are evaluated to prevent known types of failures and defects from recurring and lessons learned are disseminated to other projects. At this level measures are not only being used to improve the existing processes but also to evaluate candidate new processes.

CMM helps an organization to develop and refine an organization's software development process. There are three key roles the CMM plays. First, the CMM helps to build an understanding of the software process by describing the practices that contribute to a level of process maturity. The second role of the CMM is to provide a consistent basis for conducting appraisals of software processes. The CMM defines a scale for measuring process maturity, thus allowing an organization to accurately compare its process capability to that of another organization. ISO is using the CMM in its efforts to develop international standards for software process assessments. (*Software engineering project management, 2nd edition, p58*) The CMM's third key role is to serve as a blueprint for software process improvement. The CMM can help an organization focus on the areas it must address in order to advance to the next level of maturity.

SIX SIGMA VS CMM

Six Sigma and CMM (capability maturity model) both focus on a common goal i.e.

“Defect prevention, quality management, process involvement and process control“

The characteristics of SIX SIGMA are:

- a) Six Sigma is not domain specific.
- b) It does not include any process mode.
- c) Is data driven/measurement-driven.
- d) Six Sigma is based on customer-centric approach.

The characteristics of CMM are:

- a) CMM follows model based approach.
- b) It defines basic process infrastructure.
- c) CMM lacks standard metrics.

Six Sigma and CMM, both are different techniques used in quality management and process improvement of an organization.

4.3.1 Six Sigma is applied in a process-specific way WHEREAS Capability Maturity Model is an organizational change model i.e. it is a collection of instructions an organization can follow with the purpose to gain better control over its Software development process.

4.3.2 CMM is from the Organization point of view. It doesn't consider Customer Requirements. How to improve the Processes in an Organization? But, Six Sigma is from the Customer point of you. What the Customer needs and what his requirements are which are in turn translated into products and processes in Six Sigma.

4.3.3 Trained "Black Belts" lead process improvement projects that define, measure, analyze, improve and control selected processes WHEREAS capability maturity model reflect the steps an enterprise must take to improve its software development process capability with five levels of maturity for implementing software development practices, each level build on the lower levels.

4.3.4 CMM projects are long term & time consuming projects (*Failsafe IS project delivery, 2001, p81*) WHEREAS Six Sigma projects typically are short-term (*Six Sigma Leadership: A Study of Six Sigma Black Belts in Conjunction with Transactional and Transformational Leadership, 2007, p29*) (that is, three to six months).

4.3.5 Six Sigma's results are optimized by applying the program to iterative processes that is by constantly reviewing and re-tuning the process WHEREAS capability maturity model is designed for easy understanding and for ranking a company's IT related activities.

4.3.6 Six Sigma and the CMM also view quality from two different perspectives. The goal of a Six Sigma program is to reduce defects to a level that statistically relates to 3.4 defects per million instances or opportunities. For CMM, however, any defects occur in internal work products with negative ramifications to the completion of subsequent work. The fundamental premise behind the CMM is to improve the quality of a software product by improving the quality of the development process.

4.3.7 Six Sigma has five phases which are:

DEFINE: Defines the customer, their Critical to Quality (CTQ) issues, and the core business process involved.

MEASURE: Measures the performance of the core business process involved.

ANALYZE: Analyzes the data collected and process map to determine root causes of defects and opportunities for improvement.

IMPROVE: This phase improves the target process by designing creative solutions to fix and prevent problems.

And **CONTROL:** Controls the improvements to keep the process on the new course.

4.3.8 CMM has five maturity levels which are:

INITIAL: Processes are unpredictable, poorly controlled and reactive. They are sometime even referred as ad-hoc and chaotic.

REPEATABLE: Basic processes are established and there is a level of discipline to stick to these processes.

DEFINED: All processes are defined, documented, standardized and integrated into each other.

MANAGED: Processes are measured by collecting detailed data on the processes and their quality.

OPTIMIZING: Continuous process improvement is adopted and in place by quantitative feedback and from piloting new ideas and technologies.

SIX SIGMA AND CMM USED TOGETHER :

Challenged by the changes during the past 10 years in the importance and utilization of software by businesses, enterprises now view the cost and quality of software development differently. It is essential to maximize the use of any available tools or models that measure and improve the efficiency and effectiveness of software development.

Although two prominent approaches are available, whether to incorporate one or both is perplexing. One solution involves a Capability maturity model as a framework for improving methods and processes used for software product or service development and delivery. Another frequently considered choice is to implement a Six sigma program to address quality and customer satisfaction issues. These two approaches can be used independently and are compatible for joint use also. Often a question is raised "which amongst the two models is better?" but neither one is necessarily better, both have weaknesses.

Perhaps using both the models together helps in suppressing the weaknesses of the other model and thereby enlightening their strengths. Six sigma can be used as the tactical engine for high capability and high maturity. CMM level 4 and level 5 and Six sigma are often seen as similar. Six sigma training can help to deal with CMM's Quantitative Process Management and Defect Prevention requirements. (*Software process improvement, 2011*) CMM can clarify how to use Six sigma technique for

software process. The two can be used together to map out a process and identify gaps within software processes.

The two methods Six sigma and CMM are very well used together in Tata Consultancy Service (TCS). (www.tata.com) Tata Consultancy Services (TCS) blended Six Sigma concepts with the various CMM key process areas, thereby creating a quality management system. This helped TCS improve its customer focus and sustain process improvement initiatives by explicitly linking them to business goals. The TCS team implemented the QMS on the lines of Level 2 and 3 requirements of CMM, using Six sigma concepts to reinforce quantitative process and product measurements and analysis, process improvements for defect prevention, and process optimization. This methodology of blending Six sigma and CMM has helped the company to provide quality deliverables to its customers.

CONCLUSION

I have explained about two industrial quality improvement tools which are Six sigma and CMM. To understand something we first have to know what it is, this paper explains what are Six Sigma and CMM? What are these approaches and their levels? It distinguishes Six sigma and CMM well. And lastly explains use of both the tools together.

These tools are effectively responsible for improving a company's quality. Six sigma and CMM contribute to the growth and development of a company, producing quality goods and service thereby satisfying the customers and the employees.

Although Six sigma builds off prior quality management practices and principles, it offers a new structure for improvement. Six sigma is a systematic methodology that utilizes information and statistical analysis to measure and improve a company's operational performance. It strives for 3.4 Defects per Million Opportunities (DPMO) so that it is within six standard deviations of the mean

CMM is a process improvement model for software engineering that is divided into levels and contains a list of key process areas. It helps to set process improvement goals and priorities, provide guidance for quality processes, and provide a point of reference for appraising current processes. It is an area specific tool which focuses on specific process area which needs to be worked upon, thus more focused.

Both the models have some weaknesses which don't make them a perfect tool. Using both the models together helps in suppressing the weaknesses of the other model and thereby enlightening their strengths.

Therefore to conclude Six sigma can be used as the tactical engine for high capability and high maturity. CMM helps in using Six sigma in software processes. Six Sigma's more advanced statistical methods can be applied to assist in quantitatively analyzing data within CMM's level 4 and 5. Perhaps Six sigma and CMM can be utilized together to improve the software engineering process.

It is only through academic research that a better understanding of Six sigma and CMM can be developed. I hope that this effort of mine will provide a beginning for

future scientific research and a better understanding of this important phenomenon.

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