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BITS Pilani
Pilani Campus

SE ZG501
Software Quality Assurance and Testing
Lecture No. 13

Examples of measurements of quality of the work product

- Number of defects opened during system testing
- Number of defects opened during UAT
- Number of defects still open
- Number of defects closed
- Defect age

Examples of measurements of quality of the work product

- Total number of build failures
- Total number of defects fixed for a given release
- Total number of defects verified and accepted
- Total number of defects verified and rejected

levels of CMMI

An organization receives one of two ratings during a Class A appraisal: a maturity level rating or a Capability level rating.

Maturity levels range from 1 to 5, with level 5 as the highest grade and the target businesses aim towards.

1. Initial Level

The processes at this CMMI level tend to be erratic and reactive. The organization is at its worst at this point due to the unpredictability of the environment and the likelihood of errors and ineptitude.

2. Managed processes

- At Maturity Level 2, an organization has achieved the basic goals for its important process areas.
- This means they now plan their work, carry it out as per plan, track progress, and keep control over cost, time, and quality.
- The processes are repeatable and can be managed on a project-by-project basis.

Standards implemented at this level are usually as follows:

Requirements Management, or REQM

Project Planning (PP)

Configuration Management, or CM

Measurement and Analysis (MA)

Process and Product Quality Assurance (PPQA)

Project Monitoring and Control, or PMC

Supplier Agreement Management (SAM).

3. Defined processes

Organizations take a more preventative approach than a reactive one at this level.

Managers are now aware of the flaws and how to fix them to enhance their operations. There are several KPAs of which helps to offer direction across projects, departments, and business units.:

- Decision Analysis and Resolution, or DAR.
- Organizational Process Focus (OPF)
- Integrated Project Management (IPM) plus IPPD (Integrated Product and Process Development)
- OPD stands for organizational process definition, while OT stands for executive training.
- Product Integration (PI)
- Risk Management: RSKM
- Validation, or VAL
- Technical Solution (TS)
- Verification, VER

4. Managed quantitatively

The company has reached a high maturity level and relies on predictable methods based on the stakeholders' needs.

- Processes are well-structured, consistent, and precisely executed.
- The organization actively identifies risks and applies quantitative strategies to manage and improve processes.
- Decisions are based on measured performance data, not
- assumption ,
- This is reflected in the implementation of the following Key Process Areas (KPAs):
  - OPP – Organizational Process Performance
  - QPM – Quantitative Project Management

5. Optimizing

At **Maturity Level 5**, the organization operates in a **stable yet flexible environment** that supports continuous improvement:

- The focus is on **agility, innovation, and proactive problem-solving**.
- The company continuously seeks new opportunities for **process improvement** and **performance enhancement**.
- Improvement is driven by **quantitative feedback** and **innovative practices**, not just by reacting to issues.

Organizations at this level demonstrate a **high degree of maturity**, consistently evolving to meet the changing expectations of **clients, stakeholders, and market demands**.

Six Sigma in Software Engineering

- Six Sigma is a methodology that helps organizations in making their process better and more efficient by identifying and removing errors and variations.
- Variations in processes can lead to errors, these errors can lead to product defects and product defects can lead to poor customer satisfaction.
- By reducing variation and errors Six Sigma can reduce process costs and increase customer satisfaction.

It is a statistical concept that aims to define the variation found in any process.

Six Sigma is a process of producing high and improved quality output. This can be done in two phases – identification and elimination.

The cause of defects is identified and appropriate elimination is done, which reduces variation in whole processes.

Six Sigma processes have a failure rate of only 3.4 per million opportunities i.e. 99.99966 percent of Six Sigma products are free from defect, while Five Sigma processes have a failure rate of only 233 errors per million opportunities.

Characteristics of Six Sigma

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Statistical Quality Control: Six Sigma is derived from the Greek Letter ? which denote Standard Deviation in statistics. Standard Deviation is used for measuring the quality of output.

Methodical Approach: The Six Sigma is a systematic approach of application in DMAIC and DMADV which can be used to improve the quality of production. **DMAIC** means for Design-Measure- Analyze-Improve-Control. While DMADV stands for Design-Measure-Analyze-Design-Verify.

Fact and Data-Based Approach: The statistical and methodical method shows the scientific basis of the technique.

1. **Project and Objective-Based Focus:**
   The Six Sigma process is implemented to address specific requirements and conditions through well-defined projects and goals.
2. **Customer Focus:**
   Customer focus is a core element of the Six Sigma methodology. Quality improvements and control standards are tailored to meet the specific needs of customers.
3. **Teamwork Approach to Quality Management:**
   Six Sigma emphasizes collaborative efforts within the organization to systematically enhance quality and efficiency.

The 6 Key Principals of Six Sigma

Customer Centric Improvement

Customer Centric Improvement

The primary principal of six sigma methodology is to focus on customer.

Voice of the Customer (VoC) and methods for determining what the customer truly want from a product or process. Organizations can boost customer happiness by combining that knowledge with measurements, analytics, and process improvement approaches, resulting in **higher profits, client retention, and loyalty.**

Continuous Process Improvement

The Six Sigma approach requires constant process improvement. An organization that fully implements the Six Sigma technique never stops improving.

It continuously discovers and priorities opportunities. Once one area has been improved, the organization will move on to another.

The organization continuously find ways to increase the sigma level because the goal is to achieve the level of 99.99966 accuracy for all processes inside an organization while also making sure other essentials like financial stability.

Reduce Variation

To improve a process, it's important to reduce variation. Every process has some natural variation, but too much variation can lead to errors. These errors may cause product defects, which result in low customer satisfaction.

By reducing variation and mistakes, Six Sigma helps lower costs and improve customer satisfaction.

For example, in software development, each developer may write code differently due to their experience, style, and environment. This causes variation.

To reduce this, organizations can:

- Use coding standards and guidelines
- Conduct code reviews
- Automate testing
- Maintain proper documentation

These steps help make processes more consistent and reduce errors.

Eliminating Waste

Waste is a major problem in the six sigma methodology. Eliminating waste means removing items, procedures or people that are not required for the process's outcome or **removing anything that does not add value to customer**. Eliminating waste **can reduce processing time, errors in process and lowers overall costs.**

Empowering Employees

Until organizations provide employees with the tools they need to monitor and sustain improvements, implementing improved processes is only a temporary solution.

Process improvement usually involves two approaches in most organizations.

An improvement is first defined, planned, and carried out by a process improvement team consisting up of project managers, methodology specialists, and subject matter experts.

The employees that deal with the process on a daily basis are then equipped by that team to supervise and handle it in its improved condition.

Controlling the Process

Six Sigma improvements are frequently used to handle uncontrolled processes. Out-of-control processes meet certain statistical conditions.

The purpose of improvement is to bring a process back under statistical control.

Then, after the improvements are implemented, measurements, statistics, and other Six Sigma tools are utilized to keep the process under control. Implementing controls and training people on how to apply them is a key component of continuous improvement.

The Six Sigma Methodology

The Two Six Sigma methodologies used in the Six Sigma projects are DMAIC and DMADV.

Six Sigma teams usually use DMAIC or DMADV approaches to achieve process improvements and establish process control.

Question: An organization is working to improve its process accuracy. Initially, it has a Five Sigma quality level (233 defects per million). After implementing Six Sigma techniques, it achieves 3.4 defects per million. Which of the following BEST describes what the organization has achieved?

a) Increased the process variation and reduced customer satisfaction.

b) Reduced the process variation and improved product quality.

c) Increased the number of defects but reduced costs.

d) Reduced defects but ignored continuous improvement..

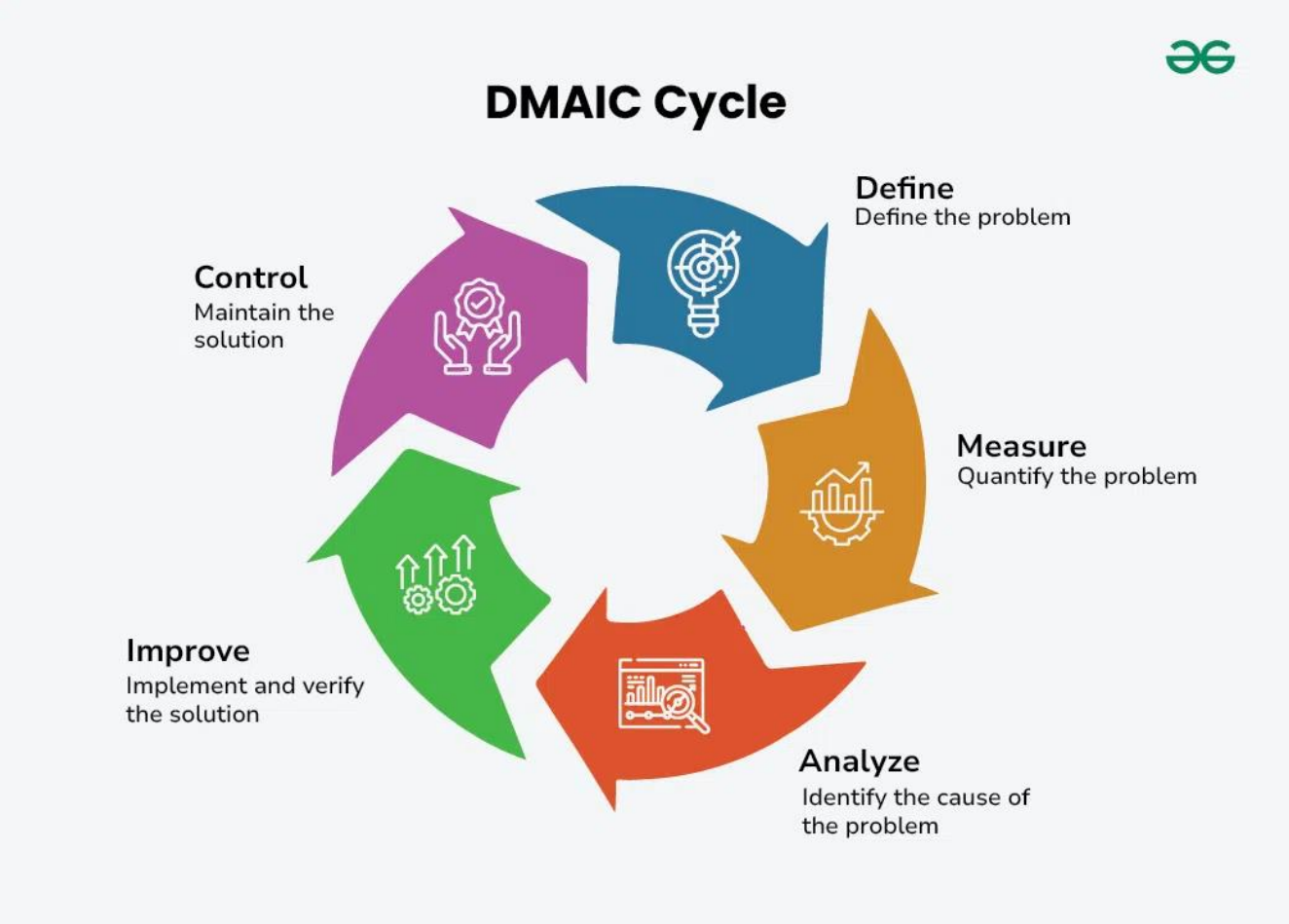
Answer: b) Reduced the process variation and improved product quality

DMAIC Six Sigma Methodology

DMAIC is used to **enhance an existing business process**.

A DMAIC project involves identifying important problem that are creating the problem, verifying those problem, brainstorming solutions, implementing them, and designing a control plan to maintain the improved state.

The DMAIC methodology is designed for the team who are responsible for improving a project.


DMAIC Cycle
Define
Define the problem
Measure
Quantify the problem
Analyze
Identify the cause of the problem
Improve
Implement and verify the solution
Control
Maintain the solution

The DMAIC project methodology has five phases:

- Define
- Measure
- Analyze
- Improve
- Control

Define

The Define phase of a DMAIC project involves identifying problems, establishing project requirements, and setting success goals.

Six Sigma leaders use specific tools during this phase to adapt the approach for different projects, based on leadership input, available resources, and budget.

Measure

In the **Measure** phase of DMAIC, the goal is to:

- **Collect data** to understand the current state of the process.
- **Use data to confirm or reject assumptions** about the problem.

This phase is important because reliable data is needed for effective analysis.

🔍 **Key Activities:**

- Gather and organize relevant data.
- Build tools or use software to extract information.
- Use filters or manual checks to process large data sets.
- Without good data, it's hard to measure or improve anything accurately.

Analyze

Analyze phase is a critical stage where the root causes of problems or inefficiencies within a process are identified and understood.

During the Analyze phase of a DMAIC project, teams develop predictions about relationships between inputs and outputs, use statistical analysis and data to validate the prediction and assumptions they've made thus far.

In a DMAIC project, the Analyze phase leads to the Improve phase, where hypothesis testing can confirm assumptions and potential solutions.

Improve

- Teams **develop and test solutions** based on what they learned during the **Analyze** phase.
- They use **statistics and real-life observations** to check if their ideas work.
- As they start applying the solutions, they keep doing **hypothesis testing** to make sure the changes are effective.

👉 The goal is to **fix the root cause** and make the process **better and more efficient**.

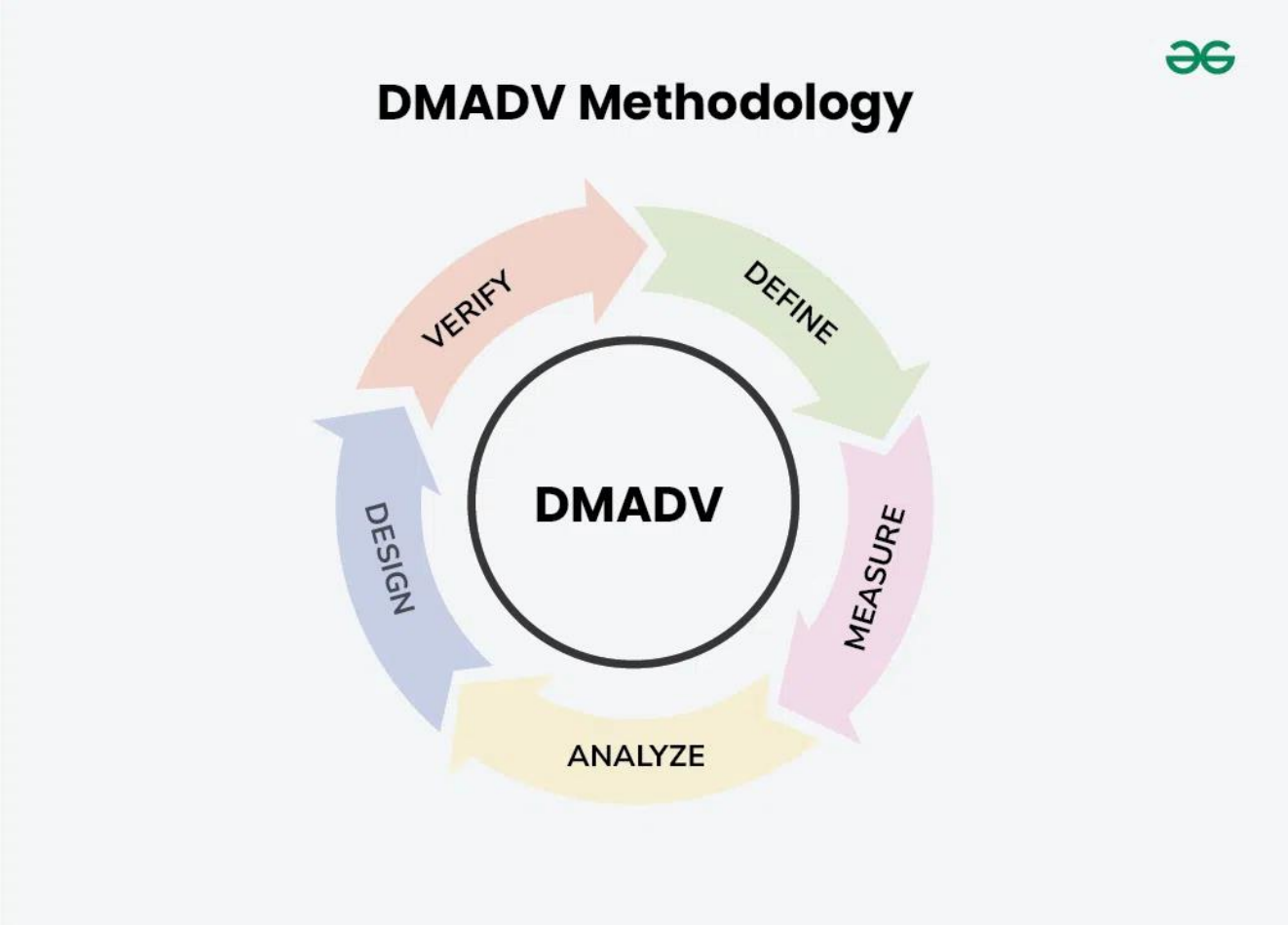
Control

- This is the **final step** of the DMAIC process.
- The goal is to **make sure the improvements last** over time.
- Teams create **rules, tools, and standards** to keep the process running smoothly.
- They also **train the people** (called **process owners**) who will manage the improved process every day.

DMADV Six Sigma Methodology

DMADV is used to create new product designs or process designs. Six Sigma teams use DMADV in the following scenario:

- The organization wants to launch a new service or product.
- Business leaders decide to replace a process to meet upgrade requirements or to align business processes, machinery, or workers with future goals.
- A Six Sigma team learns that **upgrading an existing process is unlikely to achieve the expected outcomes**, and a new design is necessary to meet quality and performance standards..


DMADV Methodology
VERIFY
DEFINE
DESIGN
DMADV
MEASURE
ANALYZE

The DMADV project methodology also has **five** phases:

- Define
- Measure
- Analyze
- Design
- Verify

Define

In the **Define** stage of a DMADV project, the focus is on understanding the problem clearly and setting project goals.

- Teams **identify the problem** or opportunity.
- Requirements are defined **based on customer needs** and expectations.
- If a **change management program** is already in place in the organization, its needs must be integrated into this stage.
- This phase sets the **foundation** for all future design work, making it more structured and clear than in DMAIC.
- Define stage is slightly more strict than in DMAIC.

Measure

During the DMADV Measure phase, teams use data to validate assumptions about the process and problem. Validation of assumptions also makes it into the analysis step. **The measurement phase focuses on collecting and arranging data for analysis**.

Analyze

Analyze phase is a critical stage where the root causes of problems or inefficiencies within a process are identified and understood. They priorities identifying best practices and standards for measuring and designing new processes.

Design

The **Design** phase is where DMADV begins to diverge significantly from DMAIC.

- In this stage, teams **create a detailed blueprint** of the new process or product.
- The focus is on building a solution from the ground up, guided by insights gained in earlier phases.
- The design process includes:
  - **Solution testing and prototyping**
  - **Process mapping and workflow planning**
  - **Infrastructure and system development**
  - **User experience and operational efficiency considerations**

👉 **Key Focus:** Designing a robust, scalable solution that meets customer and business needs.

Verify Phase

The Verify phase in DMADV checks if the designed solutions work as intended, measuring their success against initial goals, ensuring improvements are effective and sustainable.

Difference between DMAIC and DMADV

The primary difference between **DMAIC** and **DMADV** lies in their **team goals** and **project outcomes**:

- **DMAIC** is used to **improve existing processes**.
- **DMADV** is used to **design new processes or products** from the ground up.

Both methodologies aim to:

- Deliver **better quality**
- Improve **efficiency and productivity**
- Increase **profits**
- Ensure **customer satisfaction**

Conclusion- six sigma

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Six Sigma is a structured methodology used by organization to improve processes by reducing inherit variation and defects.

Six Sigma helps the organization in improving the efficiency, quality and customer satisfaction by reducing variation and defects in processes.

Six Sigma consists of two methodology DMAIC and DMADV.

DMAIC stands for “D-Define”, “M-Measure”, “A-Analysis”, “I-Improve”, “C-Control” . DMAIC is used to enhance an existing business process.

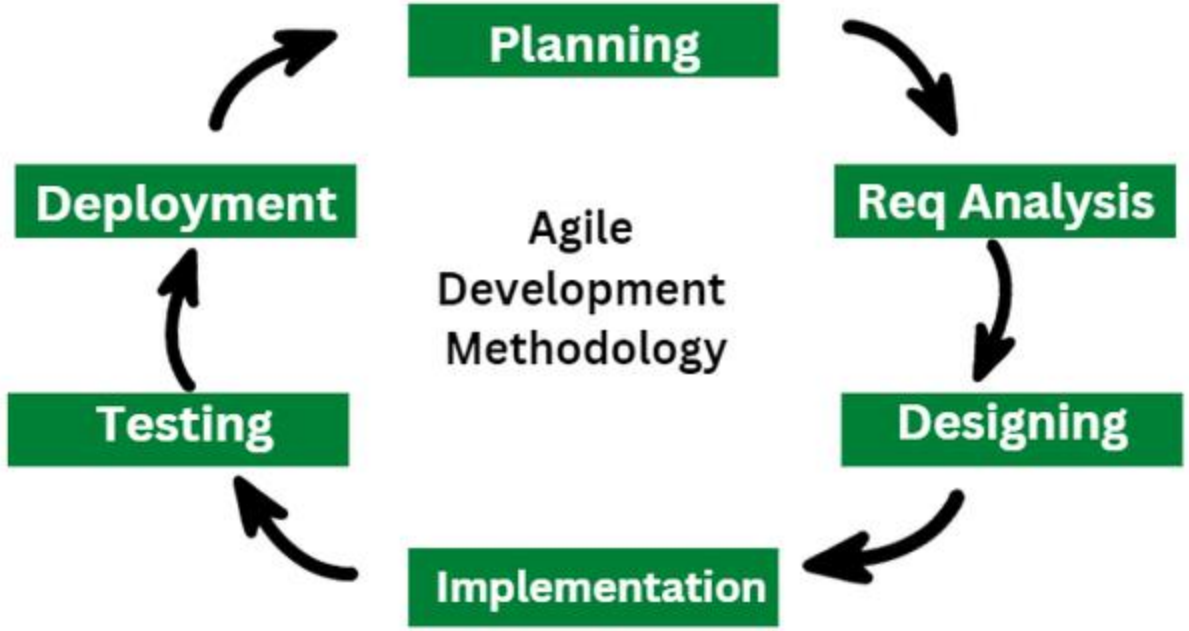
DMADV stands for “D-Define”, “M-Measure”, “A-Analysis”, “D-Design”, “V-Verify”. DMADV is used to create new product designs or process designs.

Introduction to Agile Methodology and Testing

Agile is a project_management and software development approach that aims to be more effective.

- It focuses on delivering smaller pieces of work regularly instead of one big launch.
- This allows teams to adapt to changes quickly and provide customer value faster.

Life cycle of Agile Methodology



Agile Software Testing

Agile Testing is a type of software testing that follows the principles of agile software development to test the software application.

All members of the project team along with the special experts and testers are involved in agile testing.

Agile testing is not a separate phase and it is carried out with all the development phases i.e. requirements, design and coding, and test case generation.

Agile testing takes place simultaneously throughout the Development Life Cycle.

- Agile testers are involved throughout the entire software development life cycle. They collaborate closely with developers to ensure that the software meets customer requirements. This leads to better design and more reliable code.
- The **testing team and development team function as one unified team** with a shared goal of delivering high-quality software.
- Agile Testing follows short time frames called iterations or loops.
- This approach is also known as delivery-driven, as it **enables faster feedback and better predictions** on working software within shorter time spans.