Six Sigma for quality assurance and improvement

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Agenda

- Introduction
- Six Sigma
- Methodology
- Case study: six sigma in software engineering
- Level measurements
- Team development
- Tools and technology
- Case study: blending six sigma to meet business goals
- Comparison
- Criticisms
- Conclusion
References

Introduction – quality [1/2]

• Quality
  – “Conformance to requirements”
  – “The losses a product imparts to the society from the time the product is shipped”
  – “Quality should be aimed at the needs of the customer, present and future”
  – “Quality is what makes it possible for a customer to have a love affair with your product or service”
  – “The degree to which a set of inherent characteristics fulfills the requirements, i.e., needs or expectations that are stated, generally implied or obligatory”
  – “The quality of a product is its ability to satisfy, and preferably exceed, the needs and expectations of the customers”
Introduction – quality [2/2]

• Quality concept approaches
  – Transcendent-based
  – Product-based
  – User-based
  – Manufacturing-based
  – Value-based
Introduction - quality improvement [1/2]

• Why quality improvement?

  “Quality is free. It is not a gift, but it is free. What costs money are in-quality things - all the actions that involve not doing jobs right the first time.”

  – 80% of the cost in a software engineering project is commonly related to after-delivery corrections
  – Up to 90% of the unsatisfied customers will not do business with you again, and they will not tell you
  – 95% of the unsatisfied customers will remain loyal if their complaints are handled fast and well
Introduction - quality Improvement [2/2]

• Success factors
  – More satisfied and loyal customers
  – Reduced costs due to waste and rework
  – Higher productivity
• Improved quality connects with company prosperity

- Improve quality
- Costs decrease because of less rework, fewer mistakes, fewer delays, snags, better use of machine-time and materials
- Productivity improves
- Capture the market with better quality
- Increase profits
- Stay in business
- Stay in business
Introduction - software quality [1/3]

• Software quality
  – Quality factors
    • developing in the right way
    • matching the requirement specification
    • good performance meeting customer’s expectations
    • fitness for use
Introduction - software quality [2/3]

• Software quality in line with five approach of quality
  – Transcendental view: ideal, but may never implement completely
  – User view: High quality software shall meet the user’s needs, and have a good reliability, performance and usability
Introduction - software quality [3/3]

- Software quality in line with five approach of quality
  - Manufacturing view: focuses on product quality during production and after delivery to avoid rework
  - Product view: assesses quality by measuring internal product properties
  - Value-based view: high quality product always means a high cost.
Introduction - quality improvement [1/2]

• Software process Improvement
  – Aims to have a better control in software development
  – Project divided into smaller phases, such as requirement analysis, planning, coding, testing, releasing, etc.
Introduction - quality improvement [2/2]

• Improved by process improvement because there is correlation between processes and outcomes
• Process: a sequence of steps performed for a given purpose
  – provides regular method of using the same way to do the same work
• Process improvement focuses on defining and continually improving process
• There are many models and techniques for process improvement, such
  – CMMI,
  – ISO9000 series,
  – SPICE,
  – Six Sigma, etc.
Six Sigma [1/4]

• Six Sigma
  – Bob Galvin the CEO of Motorola, 1980’s
  – Structured quantitative method
  – Invented for reducing defects in manufacturing
  – Uses statistical analytic techniques in enhancing organization’s performances, and to improving quality
Six Sigma [2/4]

• Six Sigma: a quality improvement philosophy that focuses on eliminating defects through reduction of variation in a process
• Defect: a measurable outcome that is not within acceptable (specification) limits
• Identify defects and eliminate inefficiency within the product lifecycle
• Ensures cost savings and customer satisfaction
Six Sigma [3/4]

- **Definition**
  - As a metric: ("σ")
    - used to symbolize how much deviation exists in a set of data
  - Sigma level is to show how well the product is performing

- **Software company**
  - 200,000 lines of code (loc)
  - Each loc, company performs 1 check to test quality
  - 191 defects detected

\[
\text{Defects Per Million Opportunities (DPMO)} = \frac{10^6 \times D}{N \times O}
\]

- \(D\) -> number of defects,
- \(N\) -> number of units produced,
- \(O\) -> number of opportunities per unit

\[
\text{DPMO} = \frac{10^6 \times 191}{(200,000 \times 1)} = 955
\]
Six Sigma [4/4]

– As a Methodology:
  • Managing the customer requirements
  • Aligning the processes to achieve those requirements
  • Analyzing the data to minimize the variations in those processes
  • Rapid and sustainable improvement to those processes
  • Process improvement models: DMAIC, DMADV, Breakthrough strategy, Roadmap, New Six Sigma
Six Sigma methodology

• DMAIC
  – Define, Measure, Analyze, Improve, Control
  – DMAIC also known as Lean Six Sigma focused on quality improvement over existing processes

• DMADV
  – Define, Measure, Analyze, Design, Verify
  – DMADV acts as data-driven quality strategy for new product development
DMAIC pre-requisite

Process - a series of step and procedure to deliver a service or product to customer

• Is there an existing process?
• Is there a problem affecting performances?
• Is the problem measurable?
• Does the problem affect customer satisfaction?
DMAIC - Define

• Identify and define existing problem statement through research
• Documenting problems discovered
• Benchmarking against industrial standards
• Gather input from various sources as regards to the problem
• Continuous improvement
DMAIC - Measure

• Gather measurable information
• Visualize the data with process mapping
  – Map out the cause-and-effect diagram for pattern identification
• Assign process variable to structuralize data
• Classify process variable for
  – Discreteness
  – Variation
  – Scale
DMAIC - Analyze [1/2]

• Popular strategy to analyze the data
  – Probability
  – Statistics
  – Inferential Statistics

• Analyze distribution
  – Linear correlation methods
  – Linear Regression
  – Normal distribution
DMAIC - Analyze [2/2]

• Reproducing the problem cause
  – Obtain challenges faced for the problem
• Investigating measureable baseline
• Retrieve list of loot causes for identified problems
DMAIC - Improve

• Brainstorm ideas for possible solution
• Develop improvement testing based on discovered patterns
• Implement the idea and collect data to confirm the measurable difference
DMAIC - Control

- Establish control plan
- Ensure implementations are maintained
- Standardizing the process with documented procedures
- Review and follow up
- New rounds of iteration for project ideas
DMADV - Define

- Identify purpose of the project
- Research for customer's voice
- Establish measureable goals
- Create project management flow
- Assess potential risks
DMADV - Measure

• Measure factors critical to quality
• Define requirement and market segment
• Identify design parameters
• Re-assessing risks and capability
DMADV - Analyze

• Develop design alternatives
• Optimize requirement selection
• Provide comprehensive estimation of the project lifecycle
DMADV - Design

• Finalize selection alternatives
• Establish architecture with possible prototype
• Prepare detailed model to identify potential errors for modification
DMADV - Verify

- Design is validated against stakeholder requirements
- Pilot production run to ensure quality
- Deployment of the system
Six Sigma in software engineering [1/7]

• Case study: “Six Sigma Approach in Software Quality Improvement”
  – Six Sigma approach used for software quality improvement
  – Process and tools used in each phase of the model (DMAIC)
  – Mainly targeted towards quality improvement of
    • new Product Design, training, processes, tools, and tracking
Six Sigma in software engineering [2/7]

• Define
  – Understand the problem, identify input and output variables, form the team, define goals and milestones of the project, and understand the project’s merit
  – Outputs:
    • project charter – business case, opportunity statement, goal statement, project scope, project plan, team selection
Six Sigma in software engineering [3/7]

• Measure
  – Document the existing process in order to determine what we would measure to diagnose the problem in quantitative terms
  – Standard operational definitions were used for phase containment, software reliability
  – Sigma level was determined for high severity faults, from phase containment data set, for high severity reliability defects from system test, and for CRUD (Customer Reported Unique Defect)
Six Sigma in software engineering [4/7]

• Analyze
  – investigated potential sources of variation by examining the relationship between input and output variables in order to uncover potential areas for improvement by conducting
    • Pareto analysis
    • correlation between release software size and defect injected
    • software reliability
Six Sigma in software engineering [5/7]

• Improve
  – Gathered and statistically analyzed ideas for improvement
  – Relation between injected and detected defects and release size were identified
  – Solution effectiveness was verified
  – Cost/benefit was documented
Six Sigma in software engineering [6/7]

• Improve
  – To identify and select potential solutions for process improvement
    • phase-based defect removal model: summarized the relationship among three metrics: defects escaped from previous phase, defect injection, and defect removal effectiveness
    • tactical changes plan
      – Pilot plans
Six Sigma in software engineering [7/7]

• Control
  – Team is working to ensure that the gains are sustained for the long term
  – New processes are documented, and trainings are provided
  – Efforts include
    • responsibilities - dedicated to key team members
    • performance reviews - success evaluation and tracking scheduled on a monthly basis
    • metrics for software quality tracking - Fault prediction model
Break Time

Break time arranged for 10 minutes
Sigma levels

• Statistical calculation regards to defect per opportunities
  – Sigma level provides value score to determine the quality capability of the process
  – The goal is to minimize the deviations because deviation is the enemy of quality process
Sigma distribution
Sigma level measurements

• Sigma represents variation level on normal distribution chart
• The higher the sigma level, the lower the defect rate
# Sigma level measurements - table

<table>
<thead>
<tr>
<th>Sigma Level</th>
<th>Defect Rate</th>
<th>DPMO</th>
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<tbody>
<tr>
<td>1</td>
<td>69.76%</td>
<td>697612</td>
</tr>
<tr>
<td>2</td>
<td>30.87%</td>
<td>3087710</td>
</tr>
<tr>
<td>3</td>
<td>6.68%</td>
<td>66810</td>
</tr>
<tr>
<td>4</td>
<td>0.62%</td>
<td>6209</td>
</tr>
<tr>
<td>5</td>
<td>0.023%</td>
<td>232</td>
</tr>
<tr>
<td>6</td>
<td>0.00034%</td>
<td>3.4</td>
</tr>
</tbody>
</table>
Sigma at level 4

- 99% of the time the process is operating with acceptable results
  - 50 minutes unsafe drinking water a day
  - 5,000 Incorrect surgical operations per week
  - 200,000 thousands of wrong medical perspectives each year.
  - 7 hours software malfunction per month
Benefit of Six Sigma level

• Provides understanding of quality capability in statistical way
• Demonstrate loss capacity
• Verify improvements archived
Roles and responsibilities

• Yellow belt
  – Basic understanding of Six Sigma

• Green belt
  – Lead to support intermediate Six Sigma process improvement projects

• Black belt
  – Manage and lead advanced Six Sigma project

• Master black belt
  – The master of the domain capable to instruct and educate the followers
Development team type

• Types of the Six Sigma team
  – Process improvement team
  – Celluar team
  – Self-directed team
  – Parallel team
Stages of team development

• Development stages
  – Forming
  – Storming
  – Norming
  – Performing
  – Adjourning
Tools and technology

• Value stream mapping
• JIT & KanBan
• Poka Yoke
Case study: blending Six Sigma to meet business goals [1/16]

• Many companies face challenges in aligning
  – Customer requirements
  – Process improvement goals
  – Estimating and monitoring capability with
    • time
    • effort
    • quality
Case study: blending Six Sigma to meet business goals [2/16]

• For example, TCS (Tata Consultancy Services)
  – Developed their own QMS (Quality Management System)
  – TCS-QMS was structured based on
    • SW-CMM Level 2 and 3 requirements
    • enhanced further with concepts of Six-Sigma
  – Offers an organized framework with
    • quality
    • prepares the approach to CMMI Level 5
Case study: blending Six Sigma to meet business goals [3/16]

• TCS - QMS framework history

<table>
<thead>
<tr>
<th>Year</th>
<th>Improvement description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>Documented software development practices, maintenance, and conversion to conform to ISO 9000</td>
</tr>
<tr>
<td>1995</td>
<td>Reinforced all improvement initiatives under Tata Business Excellence Model umbrella</td>
</tr>
<tr>
<td>1996</td>
<td>Adopted SW-CMM to setup, define and consistently implemented mature software processes throughout the organization</td>
</tr>
<tr>
<td>1998</td>
<td>Applied Six Sigma methods to analyze problems quantitatively with products and processes to ensure customer satisfaction</td>
</tr>
<tr>
<td>2000</td>
<td>Adopted the People-CMM to integrate people practices to sustain SW-CMM practices and ensure employee satisfaction</td>
</tr>
</tbody>
</table>
Case study: blending Six Sigma to meet business goals [4/16]

• TCS - QMS ensures customer satisfaction by
  – Designing processes with product and quality of service
  – Integrating quality control activities into software development
  – Stressing quality assurance
  – Using metrics to manage processes and quality
  – Introducing new technologies
Case study: blending Six Sigma to meet business goals [5/16]

- Key features of TCS – QMS framework
  - First, provides a basis for effective project management by monitoring
    - triple constraints
    - functionality
  - Second, provides architecture for organization
  - Third, emphasizes data – driven management
  - Lastly, facilitates continuous process improvement
Case study: blending Six Sigma to meet business goals [6/16]

• Blending CMM and Six Sigma
  – Six Sigma is customer-centric & data-driven approach
  – Focuses on reducing process variations
  – Six Sigma & CMM together
    • help organizations
    • improves marketplace competitiveness
    • achieve business goals
Case study: blending Six Sigma to meet business goals [7/16]

- Process management – Six Sigma way
  - TCS designed their metrics program by translating customer needs into operational measurements
  - Conducted extensive analysis of process trends
  - Eliminated ambiguities in calculating process capability using the sigma capability
Case study: blending Six Sigma to meet business goals [8/16]

• Customer - centric metrics program
  – Team identified the software process and product metrics
  – Tracking based on QFD (Quality Functional Development)
  – From the result of QFD
    • team selects in-process metrics
    • indicates progress based on the customer objectives
Case study: blending Six Sigma to meet business goals [9/16]

- **Customer - centric metrics program**

<table>
<thead>
<tr>
<th>Quality Function Deployment</th>
<th>Rating</th>
<th>Object-oriented design</th>
<th>Product requirements use cases</th>
<th>Traceability</th>
<th>coding standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>First house of Quality customer requirements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability</td>
<td>10</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Maintainability</td>
<td>10</td>
<td>9</td>
<td>3</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Portability</td>
<td>7</td>
<td>9</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Testability</td>
<td>5</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Total of rating x requirement</td>
<td>258</td>
<td>186</td>
<td>246</td>
<td>146</td>
<td></td>
</tr>
</tbody>
</table>
Case study: blending Six Sigma to meet business goals [10/16]

• Metrics analysis and management
  – Process variability is a key
    • natural process variation
    • special cause variation
  – For better output, reduce both the variations
Case study: blending Six Sigma to meet business goals [11/16]

• Metrics analysis and management

Control chart patterns for a sample process
Case study: blending Six Sigma to meet business goals [12/16]

• Process capability calculations
  – Six Sigma monitors the process using control charts
  – In terms of sigma capability, process capability is
    • no. of standard deviations fits between mean and specification limit
Case study: blending Six Sigma to meet business goals [13/16]

Process capability in terms of Z capability

Use of Z capability for predicting process capability
Case study: blending Six Sigma to meet business goals [14/16]

• Continuous improvement
  – Six Sigma ensures
    • meeting goals of continuous improvements
    • basis to DMAIC
  – Process mapping ensures
    • ordering of process elements
    • interfaces
    • interdependencies among elements
Case study: blending Six Sigma to meet business goals [15/16]

- Continuous improvement

Process mapping. Implemented as a CMM Level 3 process
Case study: blending Six Sigma to meet business goals [16/16]

• Benefits to the organization
  – TCS development center has various process and technology enhancements
  – For example, it implemented
    • a statement of work for capturing all project requirements
    • estimation guidelines
    • standard libraries
    • error-proofing tools
How does Six Sigma compare?

• How does Six Sigma compare to CMMI (Capability Maturity Model Integration)?
• What are the differences?
• When would each be appropriate?
What is CMMI?

- "ISACA’s CMMI model is a proven set of best practices organized by critical business capabilities which improve business performance. It is designed to be understandable, accessible, flexible, and integrate with other methodologies such as agile." - https://cmmiinstitute.com/
Understanding CMMI capability levels

- **Level 1: Initial**
  - Processes unpredictable, poorly controlled and reactive

- **Level 2: Managed**
  - Processes characterized for projects and is often reactive.

- **Level 3: Defined**
  - Processes characterized for the organization and is proactive.
    - (Projects tailor their processes from organization's standards)

- **Level 4: Quantitatively Managed**
  - Processes measured and controlled

- **Level 5: Optimizing**
  - Focus on process improvement

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AND COMPUTER SCIENCE
SCHOOL OF ENGINEERING
How to achieve CMMI compliance

• Each Level of CMMI compliance is obtained by meeting certain "Process Areas" for each level

• A "Process Area" is define as "A cluster of related practices in an area that, when implemented collectively, satisfies a set of goals considered important for making improvement in that area." - https://en.wikipedia.org/wiki/Process_area_(CMMI)
CMMI compliance example:

• To achieve level 2 the following PA's must be met:
  – CM - Configuration Management
  – MA - Measurement and Analysis
  – PMC - Project Monitoring and Control
  – PP - Project Planning
  – PPQA - Process and Product Quality Assurance
  –REQM - Requirements Management
  – SAM - Supplier Agreement Management
Six Sigma compliance

• No such compliance exists for Six Sigma the same way there does for CMMI Methodology

• Individual certification exists on belt levels: yellow, green, black. That indicate a person expertise in administration the Six Sigma workflow
How does CMMI compare to Six Sigma?

• The CMMI are a set of standards that defines the process structure. Six Sigma is a way to improve an existing process through quantitative and statistical analysis.

• Six Sigma is focused on eliminating specific defects defined by the organization to improve customer satisfaction.
CMMI and Six Sigma together?

• Six Sigma would work best when incorporated into an organization that has reached a CMMI level 3 or higher.

• Utilization of the Six Sigma methodology of statistical analysis to eliminate defect can help an organization achieve levels 4 and 5.
Case study: a CMMI level 5 and Six Sigma approach

• Identify performance and customer/employee needs
• Analyze and align business goals and organizational processes
• Establish an organizational processes structure
• Identify opportunities and establish performance goals
Criteria for classification

• Classification to determine classification either as DMAIC, DMADV, PDCA, or Simple Action
Criteria for prioritization

• Due to resource limitation prioritization must occur based on improvement opportunities and ROI
Mapping different opportunities

Table 1. Voices vs. improvement and innovation sources

<table>
<thead>
<tr>
<th>Voice</th>
<th>Improvement and Innovation Sources</th>
</tr>
</thead>
</table>
| VOE (voice of employees) | - Results of internal satisfaction surveys: the items with a higher level of dissatisfaction are selected.  
                               - Improvement and Innovation requests backlog: Specialists with great knowledge on the organization’s processes classify the requests and the most relevant are selected. |
| VOP (voice of processes)   | - Internal Audits Results: problems found in the internal ISO and CMMI audits.  
                               - Quality Assurance Results: critical and recurrent noncompliances found in QA audits are selected.  
                               - BSC Performance Indicators: problems that need to be addressed are identified based on analysis of the goals of Balanced Scorecard and the collected indicators.  
                               - Process Performance Indicators (Performance Baselines): the performance baselines indicate processes that are experiencing problems. |
| VOI (voice of innovation)  | - Improvement and Innovation requests backlog: already described.                                |
| VOC (voice of customers)   | - Results of Customers Satisfaction Surveys: the results of the last satisfaction survey are quantitatively analyzed, considering mean, variation, distribution and tendency of each criterion. The main problems that have been reported by the customers are selected based on this analysis. |

Table 2. Voices vs. improvement and innovation opportunities

<table>
<thead>
<tr>
<th>Voices</th>
<th>Improvement and Innovation Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOP (voice of processes)</td>
<td>Reduce number of defects in functional tests</td>
</tr>
<tr>
<td></td>
<td>Reduce the number of defects found by customer</td>
</tr>
<tr>
<td></td>
<td>Improve effort estimates</td>
</tr>
<tr>
<td></td>
<td>Improve cost estimates</td>
</tr>
<tr>
<td></td>
<td>Improve productivity</td>
</tr>
<tr>
<td>VOI (voice of innovation)</td>
<td>Deploy MDA architecture</td>
</tr>
<tr>
<td></td>
<td>Implement “process in action” tools</td>
</tr>
</tbody>
</table>
## DAR action classification

### Table 3. DAR table for improvement actions classification

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Critical to quality (CTQ)</th>
<th>Sales increase or cost reduction</th>
<th>Uncertain causes</th>
<th>Uncertain solutions</th>
<th>Big process change</th>
<th>Big technological change</th>
<th>Critical to customer (CTC)</th>
<th>Complex implementation</th>
<th>Result</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce number of defects in functional tests</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>9,3</td>
<td>DMAIC</td>
</tr>
<tr>
<td>Reduce the number of defects found by customer</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>8,6</td>
<td></td>
<td>DMAIC</td>
</tr>
<tr>
<td>Improve effort estimates</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>8,4</td>
<td>DMAIC</td>
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<tr>
<td>Improve cost estimates</td>
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<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>9,3</td>
<td>DMAIC</td>
</tr>
<tr>
<td>Improve productivity</td>
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<td>3</td>
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<td>3</td>
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<td>3</td>
<td>2</td>
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<td>Deploy MDA architecture</td>
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<td>2</td>
<td>6,9</td>
<td>DMADV</td>
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<tr>
<td>Implement “process in action” tools</td>
<td>3</td>
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<td>2</td>
<td>1</td>
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<td>1</td>
<td>2</td>
<td>2</td>
<td>6,6</td>
<td>DMADV</td>
</tr>
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</table>
DAR priority classification

Table 4. DAR table for complex improvement actions (DMAIC e DMADV)

<table>
<thead>
<tr>
<th>Item</th>
<th>Opportunities</th>
<th>Type of action</th>
<th>Added value</th>
<th>Urgency</th>
<th>Tendency</th>
<th>Complexity</th>
<th>Available data</th>
<th>Operational issues</th>
<th>Relation to main processes</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reduce number of defects in functional tests</td>
<td>DMAIC</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>6</td>
<td>1</td>
<td>10</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Implement &quot;process in action&quot; tools</td>
<td>DMADV</td>
<td>10</td>
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<td>7</td>
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<td>7</td>
<td>9</td>
<td>9</td>
<td>8</td>
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<tr>
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<td>DMAIC</td>
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<tr>
<td>5</td>
<td>Improve effort estimates</td>
<td>DMAIC</td>
<td>10</td>
<td>9</td>
<td>7</td>
<td>6</td>
<td>1.3</td>
<td>10</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>Deploy MDA architecture</td>
<td>DMADV</td>
<td>10</td>
<td>4</td>
<td>9</td>
<td>9</td>
<td>1</td>
<td>10</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Reduce the number of defects found by customer</td>
<td>DMAIC</td>
<td>10</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>1.04</td>
<td>4</td>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>
Criticisms

• Create additional overhead and unintended red tape
• Create large amounts of data that need to be analyzed and understood to be beneficial
• Can inhibit creativity and out-side-the-box critical thinking to solve problems
Conclusion

• Can be very beneficial to any organization looking to improve the quality and eliminate defects

• Originally created to find manufacturing defects, Six Sigma has evolved to be applied across multiple industries and disciplines
Questions?