



## Integrating Six Sigma Tools on Agile Scrum Methodology

SurendRaj Dharmapal\*

Research Scholar, Department of Computer Science,  
St. Peter University, Avadi, Chennai 600 05, India

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**Abstract**— *In this journal, we will see the best approach to integrate six sigma tools in scrum agile methodology projects. Six Sigma is a business philosophy focusing on continuous improvement, based on a statistical measure of variability. Scrum is an Agile project management methodology that can be used to control software and product development using iterative, incremental practices. Scrum generates the benefits of Agile development with the advantages of a simple implementation. This methodology can significantly increase productivity and reduce time to market. Overall six sigma focuses on reducing defects and agile focuses on rapid development. By applying six sigma tool on Scrum models helps to improve the quality and quick deliverables to customers.*

**Keywords**— *Agile, Scrum Methodology, Tools for Scrum, Six Sigma tools, scrum and six sigma*

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### I. INTRODUCTION

Six Sigma tools help to reduce defects in all phases of software development. Scrum on another side is an iterative and incremental agile software development methodology for managing software projects and product or application development. This methodology actually opens up possibilities of using appropriate tools of Six Sigma that can help improve the quality of the product.

### II. SIX SIGMA

Six Sigma methodologies provide businesses with the tools to improve the capability of their business processes and starts by asking fundamental questions based around customer requirements. Applying rigorous analysis to all processes in the business, Six Sigma can assess whether customer requirements are being met.

The five essential steps in six sigma are

#### A. DMAIC

DMAIC is used to improve an existing business process;

This Six Sigma methodology generally consists of five phases (Define, Measure, Analyse, Improve, and Control)

##### Define

- Understand and define customer requirements and business objectives.
- Define the project goals
- Define the key deliverables to customers
- Identify CTQs (critical to quality characteristics) that customers consider to have most impact on quality (the projects that will have the most impact versus those that could stand improvement but are not critical)
- Describe and quantify both the defect and the expected improvement.

The major tools used in this phase are

1. Project Charter
2. Process Flowchart
3. SIPOC Diagram
4. Stakeholder Analysis
5. DMAIC Work Breakdown Structure
6. CTQ Definitions
7. Voice of the Customer Gathering

##### Measure

- Measure the current performance of the process.
- Identify key internal processes that influence CTQs and measure defects currently generated relative to those processes
- Validate data to make sure it is credible and set the baselines.
- Create and Stratify frequency plots and conduct Pareto analysis (80/20)
- Calculate starting sigma levels

The major tools used in this phase are

1. Process Flowchart
2. Data Collection Plan/Example
3. Benchmarking
4. Measurement System Analysis/Gage R&R
5. Voice of the Customer Gathering
6. Process Sigma Calculation

Analyse

- Analyse and determine the root cause(s) of the defects.
- Create focused problem statement
- Collect Information and Data related to the problem.
- Analyse the potential causes of defects
- Use statistical methods to qualify the root causes.

The major tools used in this phase are

1. Histogram
2. Pareto Chart
3. Time Series/Run Chart
4. Scatter Plot
5. Regression Analysis
6. Cause and Effect/Fishbone Diagram
7. 5 Whys
8. Process Map Review and Analysis
9. Statistical Analysis
10. Hypothesis Testing (Continuous and Discrete)
11. Non-Normal Data Analysis

Improve

- Identify the key variables and its acceptable ranges
- Validate the deviations for the variables outside the acceptable ranges.
- Modify the process to stay within the acceptable range
- Determine the optimal solutions for root causes
- Implement the solution and Measure results
- Evaluate the results for improvement.

The major tools used in this phase are

1. Brainstorming
2. Mistake Proofing
3. Design of Experiments
4. Pugh Matrix
5. QFD/House of Quality
6. Failure Modes and Effects Analysis (FMEA)
7. Simulation Software

Control

- Control the performance of the process.
- Tools used to ensure that the key variables remain within acceptable ranges
- Develop and document standard practices
- Monitor performance are within control.

The major tools used in this phase are

1. Process Sigma Calculation
2. Control Charts (Variable and Attribute)
3. Cost Savings Calculations
4. Control Plan

B. Six Sigma Roles and Responsibilities

<b>Roles</b>	<b>Description</b>
Sponsor	Senior executive who sponsors the overall Six Sigma initiative.
Leader	Senior-level executive who is responsible for implementing Six Sigma within the business.
Champion	Middle- or senior-level executive who sponsors a specific Six Sigma project, ensuring that resources are available and cross-functional issues are resolved.
Black Belt	Full-time professional who acts as a team leader on Six Sigma projects.
Master Black Belt	Highly experienced and successful Black Belt who has managed several projects and is an expert in Six Sigma methods/tools
Green Belt	Part-time professional who participates on a Black Belt project team or leads smaller projects.
Team Member	Professional who has general awareness of Six Sigma (through no formal training) and who brings relevant experience or expertise to a particular project.
Process Owner	Professional responsible for the business process that is the target of a Six Sigma project.

III. AGILE – SCRUM

Agile SCRUM methodology recommends an empirical approach to software development, with prototypes, short delivery cycles and maximal client involvement; to ensure alignment of deliverables with clients’ needs. This methodology also provides benefits of reducing product costs and increasing revenues.

A. Important process on scrum

**Product backlog** – This is a list of potential software features or requirements for developers to work on, prioritized by value and risk. A product owner works with customers and developers to consider the next increments to deliver to increase functionality or performance of the software, or to reduce any significant risks.

**Sprint** – This is set time period (e.g., 30 days) in which the development team focuses on a set list of goals, or features. Before beginning a new sprint, the team assesses its current availability and past work habits using data and discipline connected with prior sprints to decide how much work they can pull from the product backlog into a list of features to be implemented during the current sprint (known as the sprint backlog). Central to this sprint planning is setting up conditions where team members can focus and work to their highest quality standards, without heroics, burnout, or risk of defects and waste. This is a WIP control mechanism, because it is used to pull work into the process at the sustainable rate at which it can be done well.

**Daily stand-up** – A daily stand-up meeting is held to bring to the surface issues and obstacles using three check-in questions:

1. What’s been done since the last meeting?
2. What are the team’s plans until the next meeting?
3. Are any obstacles anticipated before the next meeting?

The meeting is meant to be short and to the point. Because these open meetings are held so regularly, they provide a powerful transparency and foster learning and adaptation. With Scrum, risk and gaps connected with work completion or performance cannot hide. Whatever is going on, good or bad, will come into view in real time.

**Features delivered** – At the end of each sprint, the team delivers tested features, sometimes completing a customer project. In other cases the team delivers features that will increase the strength of an emerging product. Done well, Scrum provides insurance against losses if a project is cancelled, as the increments delivered tend to stand on their own and may have value in other projects.

B. Scrum Roles and Responsibilities

<b>Roles</b>	<b>Description</b>
Scrum Master	Communicate the value of Scrum Teach the organization on Scrum to maximize business value Facilitate Sprint Planning, Daily Scrums, Sprint Reviews and Retrospective Meetings Create the Task Board and Sprint Burn down Chart at the start of every Sprint Attend all Scrum meetings Preserve the integrity and spirit of the Scrum framework Maintain the focus of the Team Make the Team aware of impediments and facilitate efforts to resolve them Serve as a coach and mentor to members of the Team

	Respectfully hold the Team, Product Owner and Stakeholders accountable for their commitments Continually work with the Team and business to find and implement improvements
Team Member	Commit to, and self-organize, around a Sprint Goal (A Sprint Goal is different from the Sprint activities. The Sprint Goal is the intended spirit and purpose of the Sprint. So if the Team realizes in mid Sprint that a required activity for the Sprint is missing, the Team should add the activity to the Sprint so that they can deliver the Sprint Goal) Work with the Product Owner to analyse and decompose the Product Backlog items Help create and maintain the Sprint Backlog, Sprint Burn down Chart and Task Board Demonstrate the product at the end of each Sprint — during the Sprint Review Implement action items that come out of Retrospectives (essentially lessons learned) Facilitate Sprint Planning, Daily Scrums and Retrospectives if the Scrum Master is not able to do so for any reason Attend all Scrum meetings Collaborate and share knowledge and experience among the Team, Product Owner, Scrum Master and Stakeholders Help other members of the Team Look for ways to continually improve
Product Owner	Maximize business value by the Team Maintain and prioritize the Product Backlog sequentially (1 to n) Create and maintain the Release Burn down Chart Help the Scrum Master organize Sprint Review Meetings Attend Scrum Meetings Clearly communicate the business case to the Team and Stakeholders Build and maintain a relationship with the Stakeholders Support the Scrum Master to help the Team become self-organizing Report progress to the Stakeholders regularly Ensure the proper use of corporate resources and assist the Team to obtain resources as needed
Stake Holder	Work with the Product Owner to develop and maintain the Product Backlog Attend Sprint Planning meetings as needed to provide feedback and expertise Provide direct feedback to the Team during Sprint Reviews Remove roadblocks and impediments for the Team, Product Owner and Scrum Master Avoid distracting the Team during a Sprint — after the Team has committed to the Sprint Support the Scrum Framework

#### IV. INTEGRATING SIX SIGMA TOOL IN SCRUM PHASE

Below tabular column shows the important six sigma tools that can be integrated in agile scrum phases of software development.

Six Sigma Tools	Usage	Role Owner	Agile Phase
Quality Function Deployment (QFD)	QFD identifies customer requirements and rates them on a numerical scale, with higher numbers corresponding to pressing "must-haves" and lower numbers to "nice-to-haves." Then, various design options are listed and rated on their ability to address the customer's needs. Each design option earns a score, and those with high scores become the preferred solutions to pursue.  This tool can be used in Prioritization of stories and design solutions.	Product Owner	Planning Phase
Critical to Quality (CTQ)	It is used to brainstorm and validate the needs and requirements of the customer of the process targeted for improvement.  This tool can be used in Prioritization of stories given by the customer.	Product Owner, Scrum master, Team Members	Planning Phase
The voice of the customer (VOC)	The voice of the customer (VOC) technique is used in Six Sigma projects to understand customer needs. The technique guides the project team to identify the customers and collect data from them both reactively and proactively.  This tool will help in understanding the customer requirements clearly by the team.	Scrum Master, Team Members.	Planning Phase

<p>Brainstorm and Affinity Diagrams</p>	<p>This is a tool that allows one to list all sorts of innovative ideas provided by the members of a team, as a solution to any given problem. It helps in finding causes of different problems and also to identify the best solution to it. As a result of brainstorm several ideas will come up and form a list. The Affinity diagrams help sorting out the best suggestions from the list.</p> <p>This tool can help the developers to achieve various design solution and obtain the optimal one during the daily meeting.</p>	<p>Team Members</p>	<p>Development Phase</p>
<p>Poka Yoke</p>	<p>Poka Yoke is a method of preventing errors by putting limits on how an operation can be performed in order to force the correct completion of the operation. In other words, it is technology created to stop a user from becoming prone to a really serious error, even though it may be very easy for this error to occur.</p> <p>This tool can help the developers to verify what has been completed is as per the expectation of customer by showing demo in daily meeting.</p>	<p>Product Owner, Team member</p>	<p>Development Phase</p>
<p>Fishbone Diagram</p>	<p>The fishbone diagram helps identify which input variables should be studied further. To create a fishbone diagram, the problem is defined as the head of fish. Then the spine is drawn and, coming off the spine, six bones on which to list input variables that affect the problem. Each bone is reserved for a specific category of input variable</p> <p>After completing a Fish Bone Diagram, a person is able to gain a visual understanding of how many different causes or contributing factors led to an outcome. This tool also helps identify what elements or forces can be modified to alter the ultimate outcome.</p> <p>This tool can help in identifying the root cause and represent it during retrospective meeting.</p>	<p>Scrum Maser, Team Member</p>	<p>Retrospective Phase</p>
<p>The Cause-Effect Diagram</p>	<p>The most important tool to assist the project team in determining root causation is the cause-effect diagram. This tool captures all the ideas of the project team relative to what they feel are the root causes behind the current sigma performance and finally help in finding a root cause of the problem.</p> <p>This tool can help in identifying the root cause and represent it during retrospective meeting.</p>	<p>Scrum Maser, Team Member</p>	<p>Retrospective Phase</p>
<p>Failure Mode and Effects Analysis</p>	<p>FMEA or Failure Mode and Effects Analysis is the systematic procedure or tool in determining possible failure modes of any given process, product or design. It is a step by step course of action that analyses each phase or progression of the study. FMEA will also take into consideration the potential effects of the failures to the overall process goal, help planners and managers identify and prioritize failure modes and review on the results of action plans implemented. This is an effective quality management tool that is used to design a process, review and improve the process and is also an efficient process control.</p> <p>A design decision made in one iteration – based on the requirements as understood up to that point – may become a risk for a subsequent iteration as new requirements are gathered. By maintaining a FMEA for design and evaluating it at each iteration, the development team will be able to ensure that many potential failure points are analysed ahead of time.</p>	<p>Scrum Maser, Team Member</p>	<p>Retrospective Phase</p>

## V. CONCLUSIONS

Scrum & Six Sigma have both proven their value to customers in the respective domains. Agile Scrum provides improved time-to-market, high collaboration and customer satisfaction. Six Sigma provides better process controls, higher efficiency and effectiveness. Applying identified six sigma tools in Agile Scrum model will be highly effective in delivering right product first time and defect free.

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