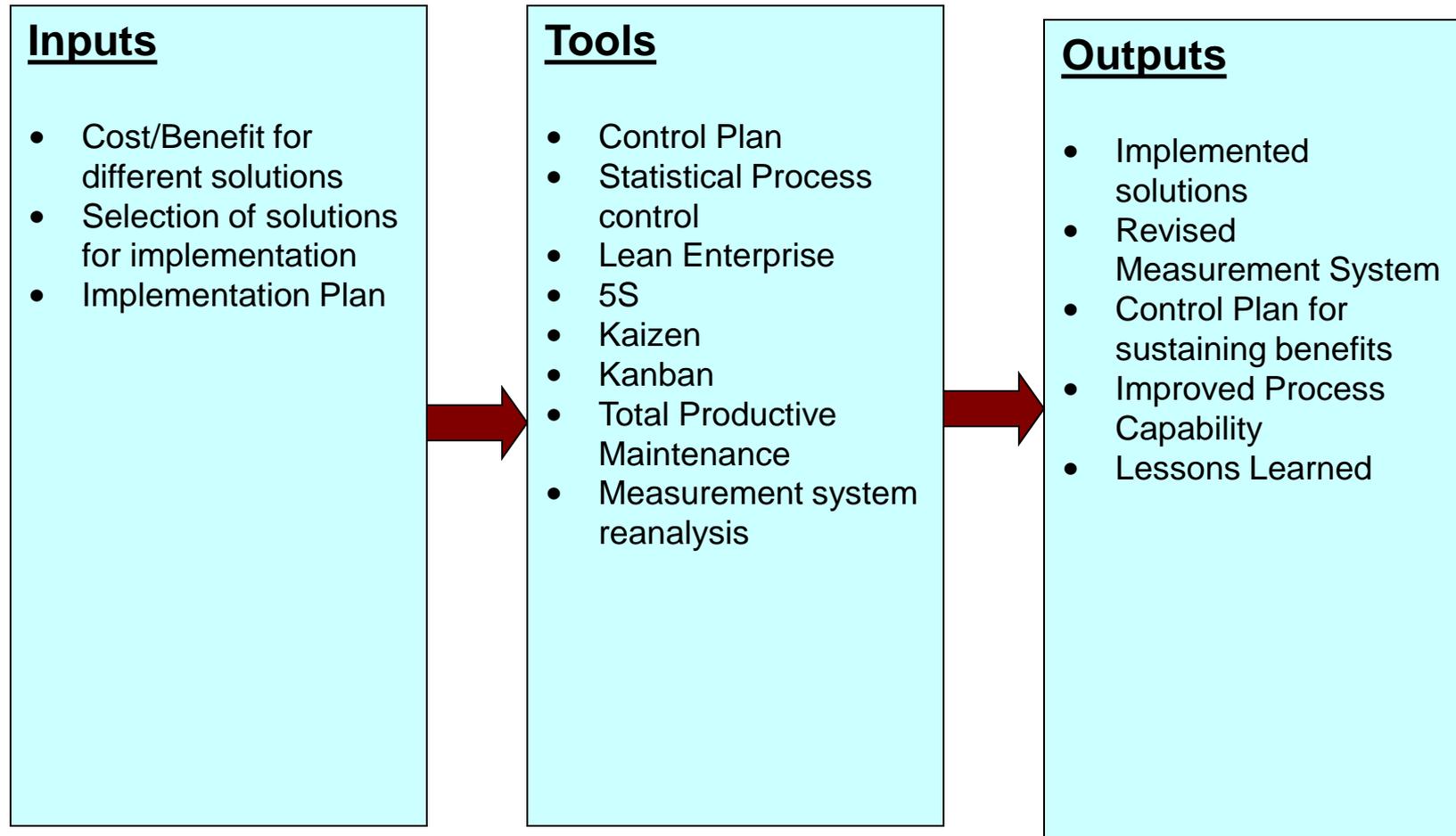


Six Sigma Green Belt - Study Guides



Index – Six Sigma Methodology (Control)



Objective of Control phase

- In Control phase, our objectives are:
 - Control project management parameters including risk, cost, scope, schedule, quality, changes etc
 - Measure the gains made by the project through Statistical Process Control, Control charts etc.
 - Ensure that the targets set by the project are achieved.
 - Ensure that gains made by the project are sustained

Inputs

- Inputs for Six Sigma Control are covered in Outputs for Six Sigma Improve. (for details, please refer to Chapter 7: Six Sigma Methodology – Improve)

Tools – Control plan

- Data collection tools and techniques are discussed in Chapter 5: Six sigma methodology – Measure. Several data collection tools are used in the Control phase of the project.
- Data collected during Control phase are used to control the process and ensure that it sustains its DPMO and sigma level.
- Control Plan:
 - Created during the Control phase of a six sigma project, the control plan is a systematic methodology to develop a data collection strategy for the process.
 - Contains information about product and process characteristics. It states the control methods to be used, data to be collected and steps to be taken if problems are detected.

Control plan (continued)

- Benefits
 - Systematically record data from the process to proactively determine that the process is under control
 - Use preventative maintenance to reduce the errors by determining the errors as soon as they occur
 - Get buy-in from all team-members who can see the results of the process and suggest continuous improvement in the process
 - Provide inputs on the CTQ (Critical to Quality) parameters which have maximum impact on meeting customer requirements.

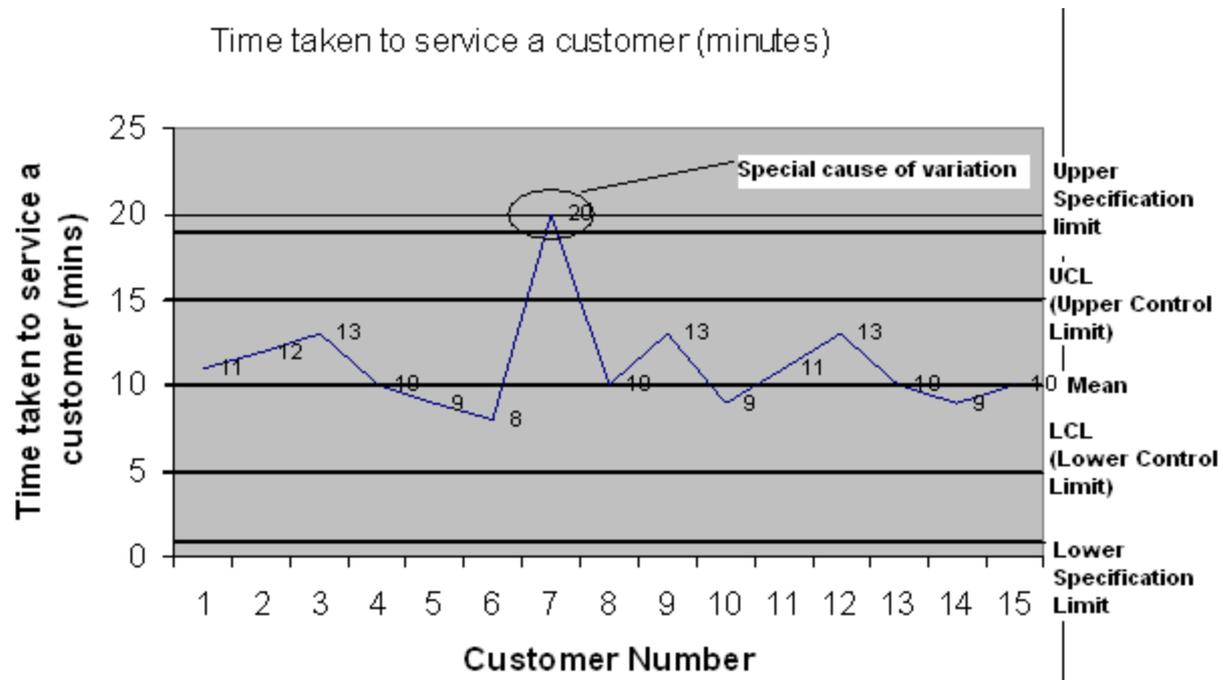
Control plan (continued)

- Creating a control plan
 - Each team may have its own control plan template which best depicts the process under study. However, all control plans must have 3 sections:
 - Header or administrative section: states who created the control plan, contact person for questions, name of person who is taking the measurement etc.
 - Process section: describes the process and its characteristics which would be measured through the control chart
 - Control Methods section: describes the data that should be collected for the process (the data to be collected depends on CTQ variables, customer requirements etc. and is determined by the project team while creating a control plan). This includes information like measurement type, sample size, levels of verification and frequency. It also has information on desired behavior, and corrective action to be taken if the process goes out of control.
 - Control plan must quantify the COPQ (Cost of poor quality) associated with failure to detect when the process is out of control.

Statistical process control

- Once data is collected using the control plan, Statistical process control (SPC) is a powerful technique to detect and rectify errors in the process.
- Most important tool used in Statistical process control is the control chart.
- Creation of control chart:
 - Information required for a control chart is similar to the information required for run charts (run charts are discussed in Chapter 5: Six sigma methodology – Measure)
 - Information required for a control chart is a count or measurement from a process whenever an event occurs or at regular time intervals. Data got is plotted in a chart as shown.

Statistical process control (continued)



Sample control chart

Statistical process control (continued)

- Important terms:
 - Mean: The **mean** of a collection of numbers is their arithmetic average, computed by adding them up and dividing by their number
 - Upper Specification Limit and Lower Specification Limit: The upper and lower specification limits are determined by taking the voice of the customer. A process would satisfy customer requirements if it falls within the specification limits
 - Upper Control Limit (UCL) and Lower Control Limit (LCL): These are defined by the six sigma expert and usually lie within the upper and lower specification limits. These are calculated from the process data and if all the process data stays within the control limits then it is very likely that the variation is inherent in the process i.e. common cause of variation. So, control limits provide boundaries for a process which is under control. If the process data lies outside the control limits, then it is a special cause of variation and indicates that the process is out of control

Statistical process control (continued)

- Out of control: A process is said to be out of control if:
 - There is process data that lies above the Upper control limit or below the lower control limit (e.g. in the diagram, we see one data point above the Upper control limit which indicates that this is a special cause of variation – hence the process is out of control)
 - Rule of seven: If there are seven consecutive data points either above the mean or below the mean, then this may be an indication of process shift i.e. the process mean may have shifted and hence the process is out of control.
- Please note: Once it is detected that a process is out of control, the project team can proactively try to determine the reasons for the process getting out of control. Steps can then be taken to bring the process back under control.

Lean enterprise

- Lean is a methodology used to accelerate the velocity and reduce the cost of any process by removing waste.
- Based on Little's law,
Lead time of any process = $\frac{\text{Quantity of things in process}}{\text{Average completion rate/Unit of time}}$.
- Lead time is the amount of time taken between the entry of work into the process to the time the work exits the process.
- Several tools like 5S, Kaizen, Kanban, Total Productive Maintenance etc. are used to decrease the things in process; thereby decreasing cycle time and costs involved in the process.

5S

- 5S or the 5 pillars of the visual workplace is a systematic process of workplace organization. Created in Japan, the intent of 5S is to have only what you need available in the workplace, a designated place for everything, a standard way of doing things, and the discipline to maintain it. The 5S's are:
 - Sort (Seiri) : Put things in order
(remove what is not needed and keep what is needed)
 - Straighten (Seiton): Proper Arrangement
(Place things in such a way that they can be easily reached whenever they are needed)
 - Shine (Seiso): Clean
(Keep things clean and polished; no trash or dirt in the workplace)
 - Standardize (Seiketsu): Purity
(Maintain cleanliness after cleaning - perpetual cleaning)
 - Sustain (Shitsuke) : Commitment
(typical teaching and attitude towards any undertaking to inspire pride and adherence to standards established for the four components)

Reference: The Improvement Book

By: Tomo Sugiyama

Kaizen

- Japanese term that means continuous improvement, taken from words 'Kai' means continuous and 'zen' means improvement
- Kaizen stresses on small and continuous improvements to the existing process
- All the people involved in the process are involved in the kaizen effort – with the objective of improving productivity and reducing defects

Kanban

- The concept behind the Kanban system is to reduce costs in high volume production lines. One way to do this is to smooth and balance material flows by means of controlled inventories. A Kanban system allows an organization to reduce production lead time which in turn reduces the amount of inventory required
- A Kanban is a card containing all the information required to be done on a product at each stage along its path to completion and which parts are needed at subsequent processes. These cards are used to control work-in-progress (W.I.P.), production, and inventory flow. A Kanban System allows a company to use Just-In-Time (J.I.T) Production and Ordering Systems which allow them to minimize their inventories while still satisfying customer demands.
- A Kanban System consists of a set of these cards, with one being allocated for each part being manufactured, that travel between preceding and subsequent processes. The Kanban System was developed (more than 20 years ago), by Mr. Taiichi Ohno, a vice president of Toyota, to achieve objectives that include[4]:
 - reducing costs by eliminating waste/scrap
 - try to create work sites that can respond to changes quickly
 - facilitate the methods of achieving and assuring quality control
 - design work sites according to human dignity, mutual trust and support, and allowing workers to reach their maximum potential.
- In order to determine optimum Kanban system designs, research often uses simulation to determine the number of Kanbans and to study various aspects of pull systems

Kanban (continued)

- The two most common types of Kanbans used today are:
 - Withdrawal (Conveyance) Kanban : The main function of a withdrawal Kanban is to pass the authorization for the movement of parts from one stage to an other. Once it gets the parts from the preceding process and move them to the next process, remaining with the parts until the last part has been consumed by the next process. The withdrawal kanban then travels back to the preceding process to get parts thus creating the cycle.
 - Production Kanban : The primary function of the production kanban is to release an order to the preceding stage to build the lot size indicated on the card
- Kanban prerequisites: Kanban is a essentially a tool that can be used to manage a work place effectively. As a result of its importance in the work place, six rules (or preconditions) have been developed to govern the operation of a kanban system. They are as follows:
 1. no withdrawal of parts without a kanban
 2. the subsequent process comes to withdraw only what is needed
 3. do not send the defective part to the subsequent process
 4. the preceding process should produce only the exact quantity of parts withdrawn by the subsequent process (ensures minimum inventory)
 5. smoothing of production
 6. fine tuning of production using kanban

Total Productive Maintenance (TPM)

- Total productive maintenance (TPM) is the systematic execution of maintenance by all employees through small group activities
- TPM is a manufacturing led initiative that emphasises the importance of people, a 'can do' and 'continuous improvement' philosophy and the importance of production and maintenance staff working together. It is presented as a key part of an overall manufacturing philosophy. In essence, TPM seeks to reshape the organisation to liberate its own potential.
- The modern business world is a rapidly changing environment, so the last thing a company needs if it is to compete in the global marketplace is to get in its own way because of the way in which it approaches the business of looking after its income generating physical assets. So, TPM is concerned with the fundamental rethink of business processes to achieve improvements in cost, quality, speed etc. It encourages radical changes, such as;
 - flatter organisational structures - fewer managers, empowered teams,
 - multi-skilled workforce,
 - rigorous reappraisal of the way things are done - often with the goal of simplification.

Total Productive Maintenance (TPM) (continued)

- TPM also places these changes within a culture of betterment underpinned by continuous improvement monitored through the use of appropriate measurement. The principal measure is known as the Overall Equipment Effectiveness (OEE). This figure ties the 'six big losses' to three measurements i.e. Availability (Time), Performance (Speed) & Yield (Quality). Six big losses include:

1. Equipment Downtime
2. Engineering Adjustment
3. Minor Stoppages
4. Unplanned Breaks
5. Time spent making reject product
6. Waste

- When the losses from Time X Speed X Quality are multiplied together, the resulting OEE figure shows the performance of any equipment or product line.
- TPM sites are encouraged to both set goals for OEE and measure deviations from these. Problem solving groups then seek to eliminate difficulties and enhance performance

Total Productive Maintenance (TPM)

- TPM benefits: Many TPM sites have made excellent progress in a number of areas. These include:
 - better understanding of the performance of their equipment (what they are achieving in OEE terms and what the reasons are for non-achievement)
 - better understanding of equipment criticality and where it is worth deploying improvement effort and potential benefits
 - improved teamwork and a less adversarial approach between Production and Maintenance
 - improved procedures for changeovers and set-ups, carrying out frequent maintenance tasks, better training of operators and maintainers, which all lead to reduced costs and better service,
 - general increased enthusiasm from involvement of the workforce.

Measurement system reanalysis

- After doing Statistical Process Control, we may need to do a periodical reanalysis of the measurement system to ensure that it is functioning as was earlier planned.
- For details on Measurement system analysis, please refer to chapter 5: Six sigma methodology - Measure

Implemented solutions

- At the end of the Improve phase, six sigma solutions are completely implemented
- Then, there is an analysis performed to ensure that the gains from the six sigma project were realized as had been forecast earlier.

Revised measurement system

- The measurement system is analyzed and recalibrated if required to ensure that it continues to be accurate and can provide appropriate information required for SPC and other control activities

Control plan for sustaining benefits

- A control plan for sustaining benefits is created as was discussed earlier in the chapter

Improved process capability

- Once the six sigma project is implemented, the process capability improves.
- For more information on process capability, please refer to Chapter 5: Six Sigma Methodology - Analyze

Lessons learned

- Not all six sigma projects are successful i.e. they may not get the benefits as was earlier planned.
- Lessons learned from the six sigma project (including successes and failures) should be well documented and shared across the organization. This will help other six sigma projects in the organization leverage the knowledge to improve their process.
- Benefits from lessons learned
 - Reduced overall costs
 - Increased efficiency
 - Improved customer service
 - Better morale
 - Increased ROI from six sigma