SHOW ME EXCELLENCE PLAYBOOK

Revision Date 6/25/2020

Introduction

What is Operational Excellence (OpEx)?

Operational Excellence drives the "management cycle" with skills, capabilities, mindsets, and processes to deliver performance and organizational health and continuously improve our departments.

What is Show Me Excellence?

Show Me Excellence is a subset of OpEx skills, capabilities, mindsets, and processes that deliver lean and continuous improvement impacts at the department, team, and project levels.

Why is Show Me Excellence important to the State of Missouri?

The playbook connects you to the greater State of Missouri continuous improvement community, in order to reduce waste and increase efficiency in the work we do to add more value to our citizens. We use a common playbook to create common language on a shared problem-solving approach as we continue to grow capabilities. Many of the tools and methods shown in this playbook are enabled through principles of Lean and Six Sigma methodology which has been enhanced and spun into Process and Operational Excellence best practices. The State of Missouri uses these world-wide standards and best practices to create a mindset of continuous improvement.

What is this playbook for?

The playbook is designed to help the State of Missouri departments better understand the mindset of problem solving and the methods available through Operational Excellence. The playbook focuses on an organizational improvement philosophy and the set of methods that are common to the State of Missouri through shared best practices around the world. In this effort, we take a "Show Me" approach through describing each tool in detail along a common problem-solving map.

Who is this playbook for?

This playbook is for team members who have gone through Yellow or Green Belt training and is intended to supplement that training.

How to use the Show Me Excellence Playbook

The Show Me Excellence Playbook provides State of Missouri team members with instructions on how to use a variety of problem-solving tools. Each tool is fully explained and includes the following resources:

- Reasons to use each tool
- Step-by-step instructions
- Examples
- Templates
- Links to external training

A3

What is an A3?

The A3 is a visual aid to succinctly illustrate the progress of a project to a team member. We use the A3 to tell the story of the problem we are experiencing, what is causing it, and what we can do about it. The A3 document is broken up into three phases (plan, innovate, sustain). These phases are aligned to the Lean Six Sigma methodology of **D**efine, **M**easure, **A**nalyze, **I**mprove, and **C**ontrol (DMAIC). The Plan phase is aligned to identify the tools and deliverables. The Innovate phase includes measure, analyze, and improve. The Sustain phase is the equivalent of control.

The A3 is a process document used for problem solving. This process was first developed by Toyota to foster learning, collaboration, and personal growth throughout the duration of a project. The term "A3" is derived from the particular size of paper used to outline ideas, plans, and goals throughout the A3 process. A3 paper is also known as 11" x 17" or B-sized paper.

An A3 tells the story starting at the top left side of the page, all the way to the bottom and then to the top right and back down to the bottom. While there are several formats for an A3, the State of Missouri uses the "The Missouri Way A3" format (TMW A3).

TMW A3 problem-solving tool is divided into three phases:

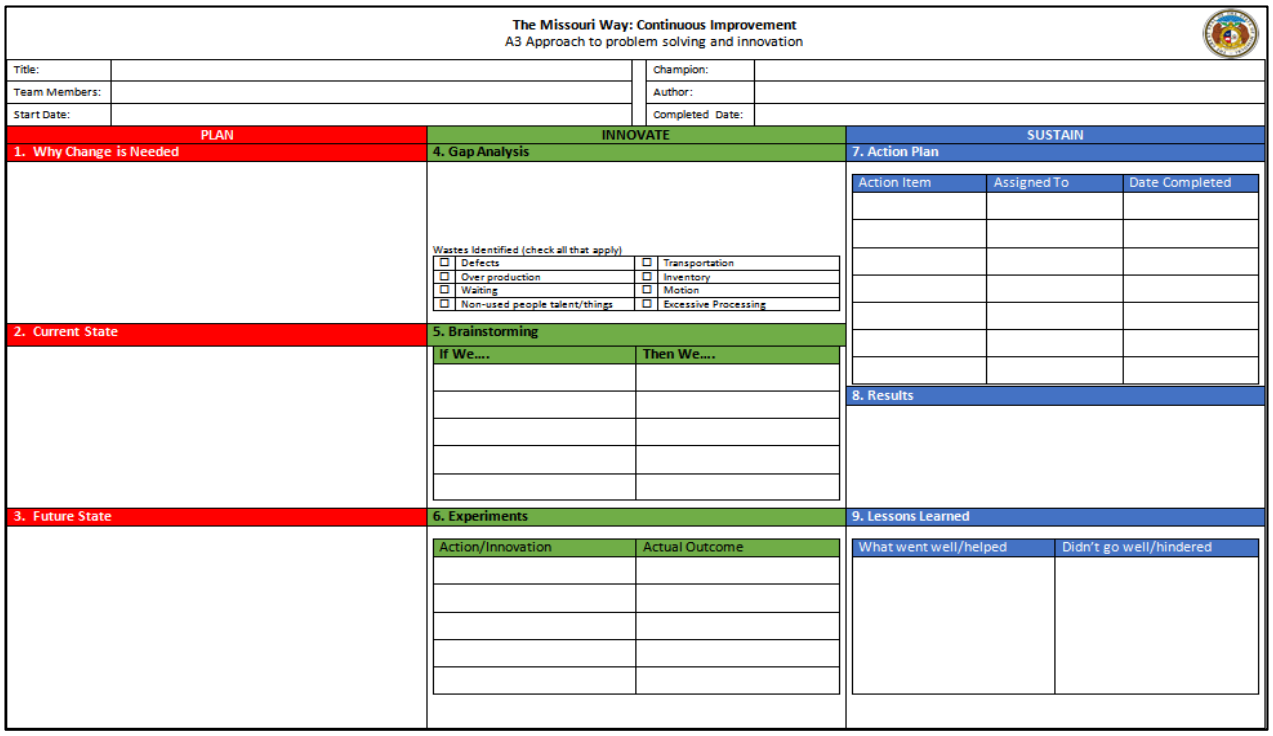
The objective for the **Plan** phase of the A3 is to establish the need for the project, where we are currently, and what our desired state is. The difference between our current performance (our baseline) and our desired future state represents the level of capability that we are trying to build. The deficiency in our capability represents "what we are solving for".

The **Innovate** phase is our attempt to build such capability. In order to do so, we must understand the obstacles that exist in our current state, and what we can do about them. These obstacles are often risks that go undetected or redundant steps/processes that add little value to meeting the customer's needs. The Innovate phase is also where we get to test out the improved capability.

Assuming we have built the right level of capability to consistently produce our desired outcomes, we are now ready to move to the **Sustain** phase. In the Sustain phase, we deploy our new capability/solution to the owners, where it becomes part of our standard practices.

Each of these phases consist of three steps, for a total of nine steps. Each step is equipped with tools that are used to gather and analyze information to answer each question.

The Missouri Way (TMW) A3 Template



The Missouri Way: Continuous Improvement
A3 Approach to problem solving and innovation

Title:		Champion:	
Team Members:		Author:	
Start Date:		Completed Date:	

PLAN

1. Why Change is Needed

2. Current State

3. Future State

INNOVATE

4. Gap Analysis

Wastes Identified (check all that apply)

☐	Defects	☐	Transportation
☐	Over production	☐	Inventory
☐	Waiting	☐	Motion
☐	Non-used people talent/things	☐	Excessive Processing

5. Brainstorming

If We....	Then We....

6. Experiments

Action/Innovation	Actual Outcome

SUSTAIN

7. Action Plan

Action Item	Assigned To	Date Completed

8. Results

9. Lessons Learned

What went well/helped	Didn't go well/hindered

How do you know if your problem needs an A3?

Perform the following simple pre-work. If your situation checks one or more of the following boxes, use the A3 problem-solving tool:

- ☐ The situation is tricky (complicated or complex) enough to warrant using an A3 to provide structure.
  - Complicated in that it has a lot of moving parts, but fairly easy to grasp and understand.
  - Complex is that in addition to a lot of moving parts, it requires more than just a general understanding or ability to grasp generalities. Many unknowns and interrelated factors exist.
- ☐ There will be on-going discussion about the issue.
- ☐ The A3 report has communications value.
- ☐ Team members will experience personal ownership and development from inclusion.
- ☐ Cross-functional collaboration is needed.

The Missouri Way – A3

	Define	Measure/Analyze/Improve	Control
Phase	**Plan**	**Innovate**	**Sustain**
Steps	1. Why is change needed? 2. What is current state? 3. What is the desired state?	1. What are the root causes? 2. How can we solve for the root causes? 3. How can we experiment with our ideas?	1. What is our plan to implement? 2. What are the results? 3. What are our lessons learned?
Tools	1.1 VOC 1.2 Run Chart 2.1 Dashboard 2.2 SIPOC 3.1 Team Selection 3.2 Charter	4.1 Process Maps 4.2 Cause and Effect Diagram 5.1 Graphical Analysis 5.2 Failure Modes and Effect Analysis (FMEA) 6.1 Impact/Effort Chart 6.2 Prioritization	7.1 Project Plan 7.2 Gant Chart 8.1 Revised Run Chart 8.2 Feedback Survey 9.1 Plus/Delta 9.2 Celebrate
Deliverables	❑ Project sponsorship ❑ Key stakeholders ❑ Performance baseline ❑ Business case and problem statement ❑ Goals, roles, milestone plan ❑ Improvement goals	❑ Understanding what is causing the problem ❑ The vital few ideas that can have the greatest impact ❑ What's the improvement? ❑ Solution validation	❑ Implementation team, timeline & expected results ❑ Change management plan (Communication, training, etc.) ❑ Control plan ❑ Shared results & celebration

Phase: Plan

Step 1.0: Why is change needed?

- Internal and/or external customers are complaining (i.e., services are taking too long)
- Organization has self-identified performance deficiencies
- Legislative or mandated procedure changes

Tool 1.1: Voice of the Customer (VOC)

Definition: What is critical to the quality of the process… according to your customer!

A key method to do this is to collect input from the customer. This can be done using the following VOC tools:

- Surveys
  - Pros: Lower cost approach, can produce faster results
  - Cons: Can get incomplete results, skipped questions, unclear, low response rate
- Focus Groups
  - Pros: Group interaction generates information, more in-depth responses, can cover complex questions
  - Cons: Data collected typically qualitative vs. quantitative, can generate too much anecdotal information
- Interviews
  - Pros: Can tackle complex questions and a wide range of information, can use visual aids
  - Cons: Long cycle time to complete, requires trained, experienced interviewers

Once you've collected the Voice of the Customer, it is time to translate it into a requirement.
The Voice of the Customer provides the verbatim wishes of the customer that is translated into a need, that is then translated into a requirement.

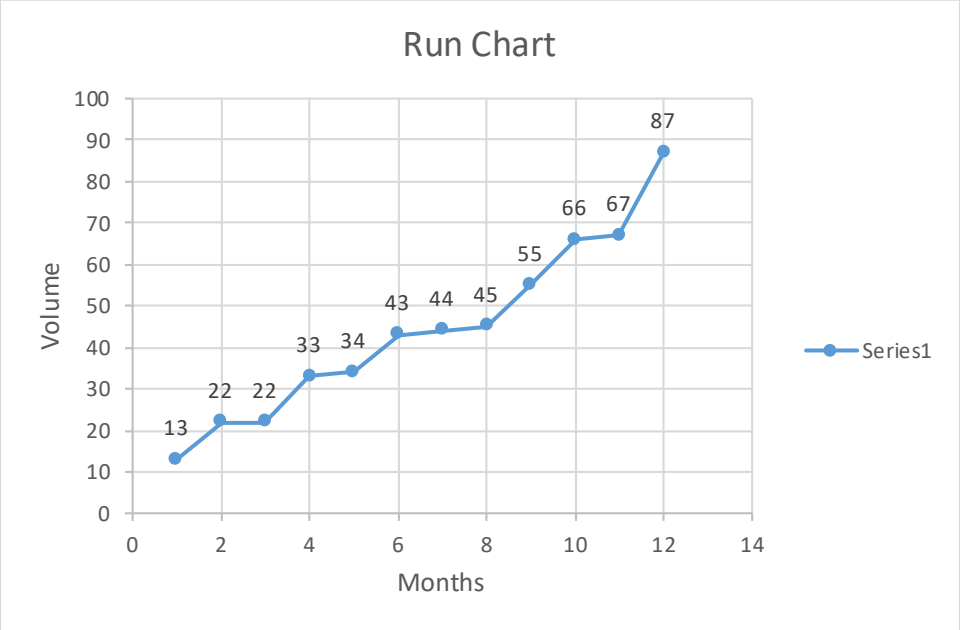
Example:

VOC (verbatim): I hate waiting on hold to talk to someone
Need: Get help ASAP
Requirement: Shorter wait times
Measure: Length of hold time
Metric: Answer 80% of calls within 60 seconds

Assuming that the stated metric will satisfy the customer's need to get help as soon as possible, this becomes the goal of the capability we need to build.

Tool 1.2: Run Chart

What is a Run Chart? A Run Chart helps to identify trends. Run charts are therefore used to conduct trend analysis. It is a series of data points plotted on a graph over time to visually depict the behavior of a process. For example, if you plot monthly data over a period of 12 months that shows a continuous incline, there's no reason to believe anything will change if left to its own accord. Generally speaking, if it is not headed in the direction you desire or expect, you would take an action to bend the curve.



Step 2.0: What is the current state?

The current state captures the current process and the performance baseline. The baseline is the output baseline of the current process. If we are receiving complaints, and our current performance is meeting target measures, then the problem is that we need to set new targets. The question then becomes, is the current process capable of meeting those new targets? If the answer to this question is yes, then there is no need to do a project. The source of the problem, therefore, would be adherence to the process.

If the answer is no, then we need to explore the obstacles that are preventing the process from meeting these new targets. Generally speaking, customer complaints are going to be associated with not meeting existing targets.

Tool 2.1: Dashboard

Dashboards are visual tools used to communicate measurements of day-to-day operations. Dashboards are generally tied to productivity goals that measures our operational efficiency. The design of a dashboard is generally specific to the area that it serves.

Tool 2.2: SIPOC

A SIPOC provides a more detailed understanding of a process by identifying **S**uppliers, **I**nputs, **P**rocess, **O**utputs, and **C**ustomers. It's a tool summarizing the inputs and outputs of one or more processes in table form.

Suppliers	Inputs	Process	Outputs	Customers
• DOD Procuring Activities	• DOD Contract ▪ Foreign Supplier ▪ DFE Entitlement Clause • Also CO/ACO (DLA/Depots)	DFE Entitlement Requested	• War Material • Major End Items • Finished Product • Completed Entitlement Request	• Military Services • Military Depots
• DOD Contracting Officers (ACO)	• DOD Contract ▪ Contract review ▪ Entitlement approval ▪ Entitlement disapproval • DFE etool	Entitlement Approved	• Completed Entitlement Request	• DOD Procuring Activities • Contractors
• Contractors	• Foreign source raw material ▪ Import shipment ▪ Duty ($) ▪ Entitlement request • DFE etool • DOD Contract	Material Imported	• Import Shipment Receipt • DFE Certificate • Duty ($)	• Military Services/Depots • DOD Procuring Activities • DOD Contracting Officers
• Customs Brokers	• Raw Material ▪ Entitlement request ▪ Certificate request ▪ Duty ($)	Certificate Requested	• Import Shipment • DFE Certificate • DFE Denial	• Contractors
• DCMA Customs	• Certificate request • DOD contract • Entitlement request	Certificate Issued	• DFE Certificate • DFE Denial	• Military Services/Depots • DOD Procuring Activities • Customs Brokers/US Customs & Border Protection/ US Census Bureau

- SIPOC diagrams help a team and its sponsor(s) agree on project boundaries and scope.
- A SIPOC is very similar to a flowchart, but shows the inputs and output connections. High-level process steps can help in identifying milestones for action plans.
- SIPOC diagrams define people and steps that are part of a process, to ensure the right people are on the project. When making a process map, use the people in the SIPOC diagram as the people for the swim lane map. Put the steps in order in the lane(s) for the people doing those steps.
    - SIPOC diagrams arranges processes on a table where the rows show "what and who" need to do each step: What is the output, what/who is the supplier, what is the input, what is the process, who are the customers?
    - When you cannot answer the "what or who", these are known as "gaps" in information or in details.

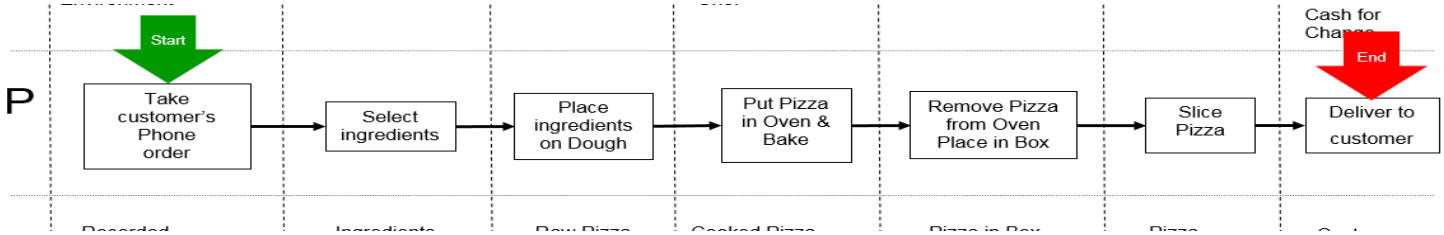
How do you use a SIPOC?

A SIPOC captures information crucial to a project. The table below provides instruction for identifying and completing each SIPOC element.

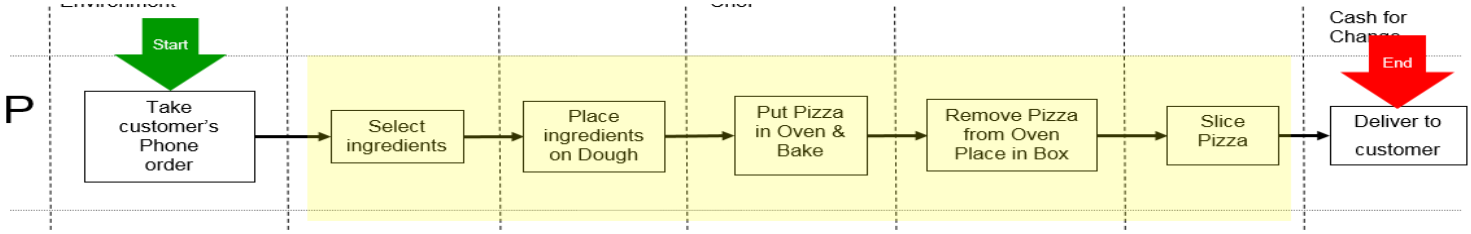
Supplier(s)	Inputs	Process Steps	Output(s)	Customer(s)
People/entities providing input(s) to a process.	*Items used to generate outputs; materials, resources and data required to carry out the process*	*Activities performed; specific to high level steps*	*Results of the process steps/activities*	*People/entities who receive and use the outputs or directly benefit/impacted by activities*
•	•	1.	•	•
•	•	2.	•	•
•	•	3.	•	•
•	•	4.	•	•
•	•	5.	•	•
•	•	6.	•	•
•	•	7.	•	•
•	•	8.	•	•
•	•	9.	•	•
•	•	10.	•	•

Step by Step: How to Use a SIPOC

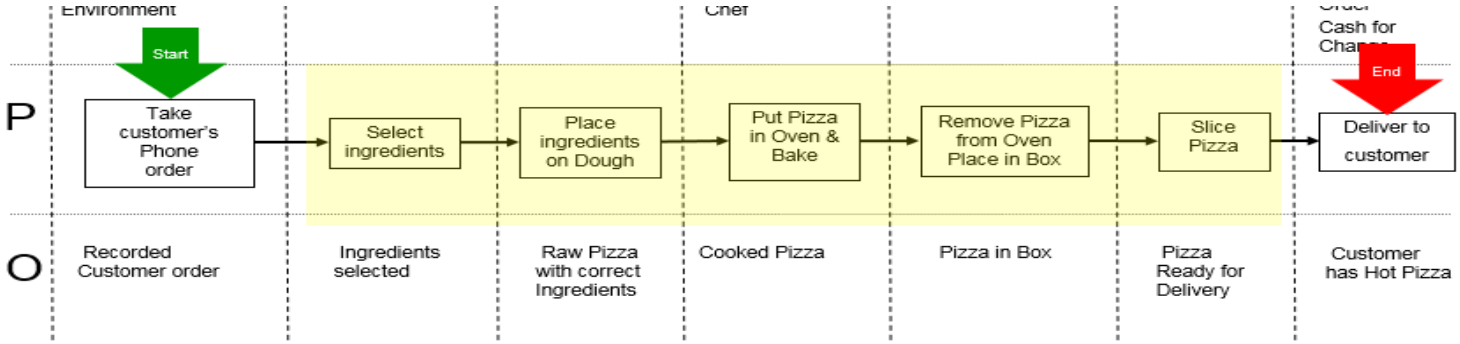
1. List beginning and ending process steps (boundaries).
    - You may have this information from your process map.



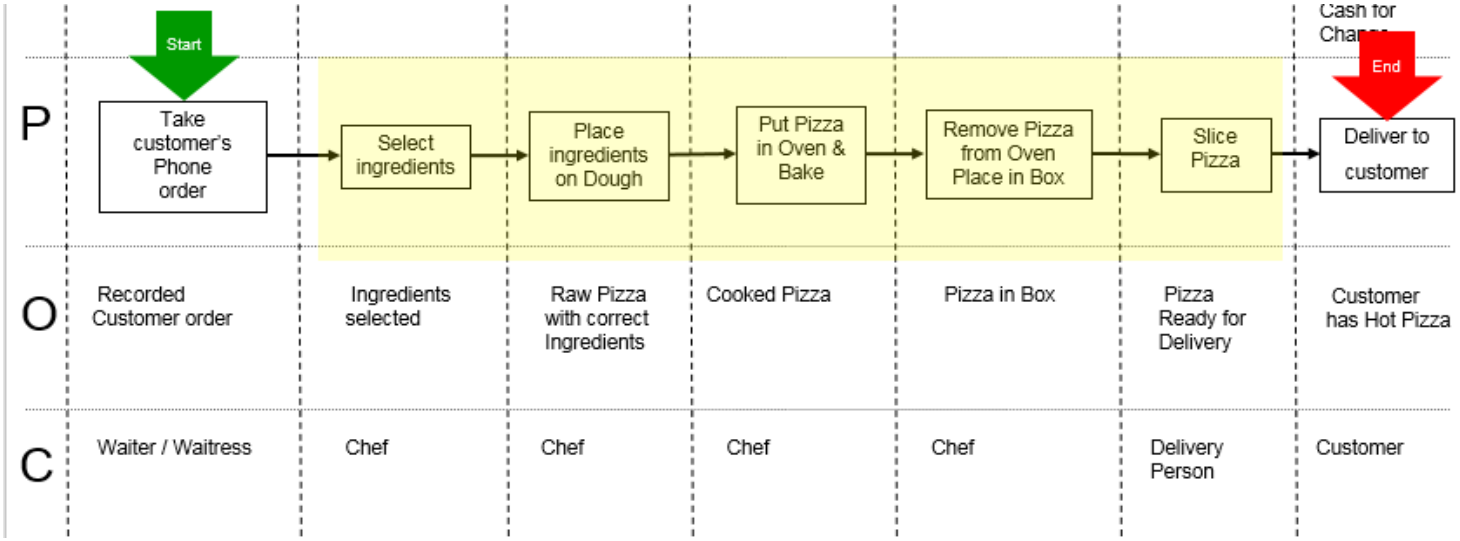
2. List four to six high-level steps between the start and end of the process.
    - What happens to each input?
    - What transformation activities take place?



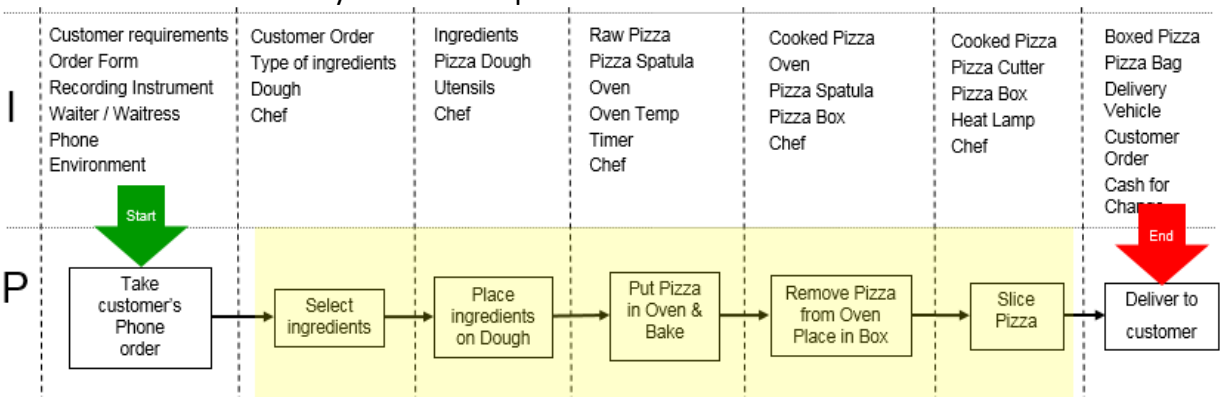
3. List key outputs.
    - What does this process produce?
    - What are the outputs of this process?
    - Where does this process end?



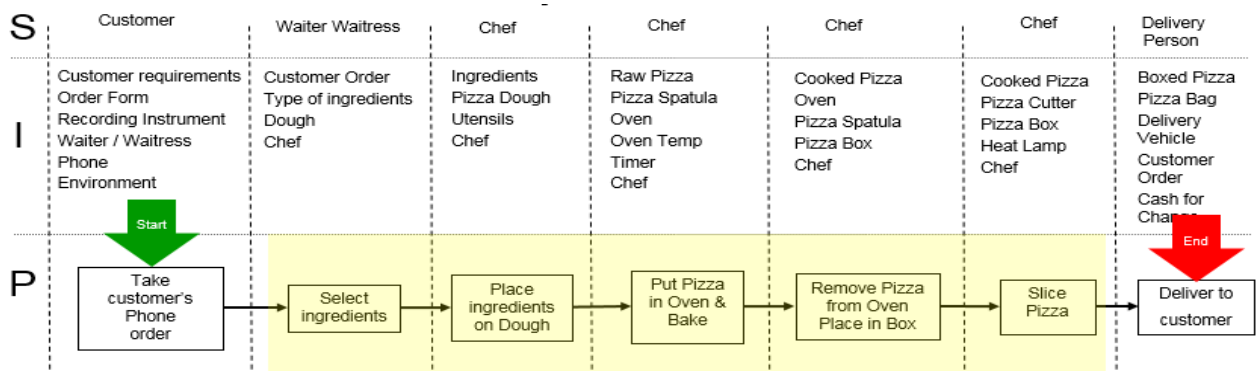
4. List the customers of those outputs.
    - Who uses the product of this process?
    - Who uses the process?



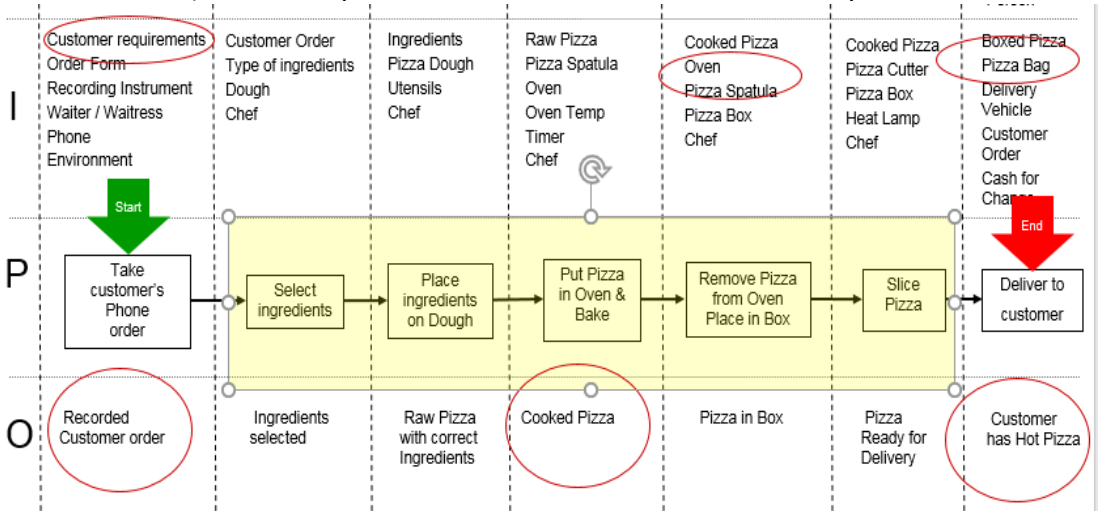
5. List inputs.
    - Where does the information or material that you are using come from?
    - Who are your suppliers and what are they supplying?
    - Where do they influence the process course?
    - What effect do they have on the process and its outcome?



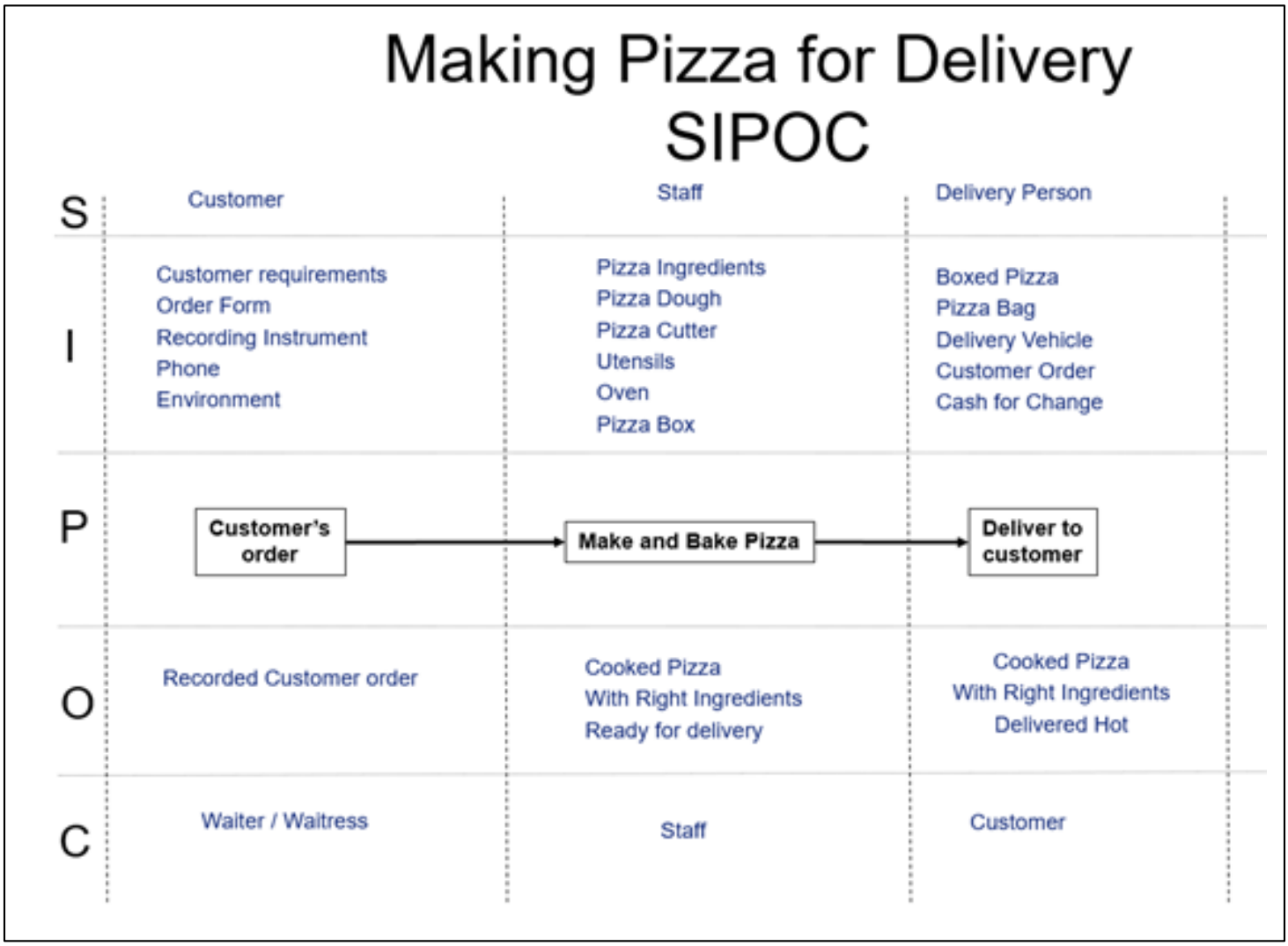
6. List suppliers of inputs.
    - Where does the information or material that you are using come from?
    - Who are your suppliers and what are they supplying?
    - Where do they influence the process course?
    - What effect do they have on the process and its outcome?



7. Identify critical must-haves for the inputs and outputs (you will have to verify this information later with data collection). The example below came from a customer survey for the store.



The Completed SIPOC



- Be very specific about where the process starts and ends. The starting and ending steps in the process should align with the scope of your project. Watch for steps where there is input, but no output – these areas are where improvements can be made.
- Inputs and outputs are usually forms or documents, sometimes they are activities; this all depends on the process. Inputs are what have to occur such as correct information being keyed in a system within a certain timeframe. An input could also be something signed and dated, stamped by staff, or signed by supervisor, etc.
  Output example: Customer receives what they asked for and is satisfied.

Checklist before creating a SIPOC:

- ☐ Complete a high-level Process Map
- ☐ Set up a meeting with the stakeholders indicated on the Process Map
- ☐ Voice of the customer data gathering to know what the customer wants
- ☐ Facilitator guide below
- ☐ Sticky notes if whiteboard is not available, use different colors
- ☐ Whiteboard
- ☐ Use different dry eraser marker colors if possible

Facilitator Guide Instructions

1. Identify beginning and ending process steps
2. Identify four to six high-level steps in the process
3. Identify key outputs
4. Identify the customers of the outputs
5. Identify inputs and suppliers
6. Identify must-haves for the inputs, process steps, and outputs. This information will be used in data collection

Additional SIPOC Resources

- SIPOC instructional video on MOLearning
  - Richard Chua: Lean Six Sigma: Define and Measure Tools (SIPOC)
- SIPOC instructional video on YouTube
  - SIPOC: SIPOC

SIPOC may also be spelled backwards as COPIS, when putting the needs of the customer first, reversing the original order.

Step 3.0: What is the desired state?

Depending on the type of solution, the desired state may simply be restating already defined targets. This would occur if we're experiencing a performance deficiency. If the current target performance isn't meeting customer expectations, then the new desired state would be the target metric created from the VOC. The desired state may also include goals associated with byproducts of the process, for example, increased employee engagement, lower costs, etc.

Tool 3.1: Team Selection

All projects should have a project sponsor. In addition to sponsors, there are other stakeholders that the process impacts. These are identified in the SIPOC. Green belt project teams are usually three to five people. If you find it necessary to have more than five members of the team, the complexity of the project may be beyond the green belt toolkit. In addition to the sponsor, team selection includes the project leader and one to three subject matter experts.

Tool 3.2: Charter

A team charter is a vital part of the project's overall success. It communicates the project direction to all team members and key stakeholders.
The purpose is it:

- Clarifies what is expected of the team, keeps the team focused;
- Keeps the team aligned with organizational priorities; and
- Facilitates the transfer of the project from the champion to the improvement team.

Term	Definition
Business Case	An explanation of why you are doing the project.
Problem Statement	A description of the problem/opportunity in clear, concise, measurable terms. It does not assign blame or assume the cause.
Goal Statement	A description of the objective in clear, concise, measurable terms. It does not propose a solution.
Project Scope	Identifies the focus and boundaries of the project, as well as process dimensions and available resources.
Milestones	A preliminary, high level project plan with key steps and dates to achieve goal.
Roles	Identifies team members and their role and responsibilities for the project.

Procedure Answer the questions and review the statements in the following sections to create the key elements of a Team Charter.

Business Case

- Why is the project worth doing?
- Why is it important to do now?
- What are the consequences of NOT doing the project?
- What activities have a higher or equal priority?
- How does it fit with business initiatives and target?

Problem Statement

- What is wrong or not meeting our customer's needs?
- When and where do the problems occur?
- How big is the problem?
- What is the impact of the problem?

Goal Statement

- Defines the improvement objective the team is seeking to accomplish.
- Starts with a verb (reduce, eliminate, control, and increase).
- Tends to start broadly, eventually should include measurable target and completion date.

Project Scope

- What process will the team focus on?
- What are the boundaries of the process we are to improve? Start point? Stop point?
- What resources are available to the team?
- What (if anything) is out-of-bounds for the team?
- What (if any) constraints must the team work under?
- What is the time commitment expected of team members?
- What are the advantages to each team member for the time commitment?

Milestones Milestones should be:

- Tied to phases of the DMAIC process
- Aggressive
- Realistic

Roles

- How do you want the champion to work with the team?
- Is the team's role to implement or recommend?
- When must the team go to the champion for approval?
- What authority does the team have to act independently?
- What and how do you want to inform the champion about the team's progress?
- What is the role of the team leader (Black/Green Belt) and the team coach (Master Black Belt)?
- Are the right members on the team? Functionally? Hierarchically?

Deliverables You must deliver a:

- Business Case
- Problem and goal statements
- Project scope
- Team roles
- Project milestones

Phase: Innovate

Step 4.0: What are the root causes?

Generally speaking all outcomes are both causes and effects. Determining the root cause therefore is deciding which of the causes we will change in order to increase our capability to achieve the desired effect. There are many tools that can be used to perform root cause analysis. This playbook will focus on a few of them.

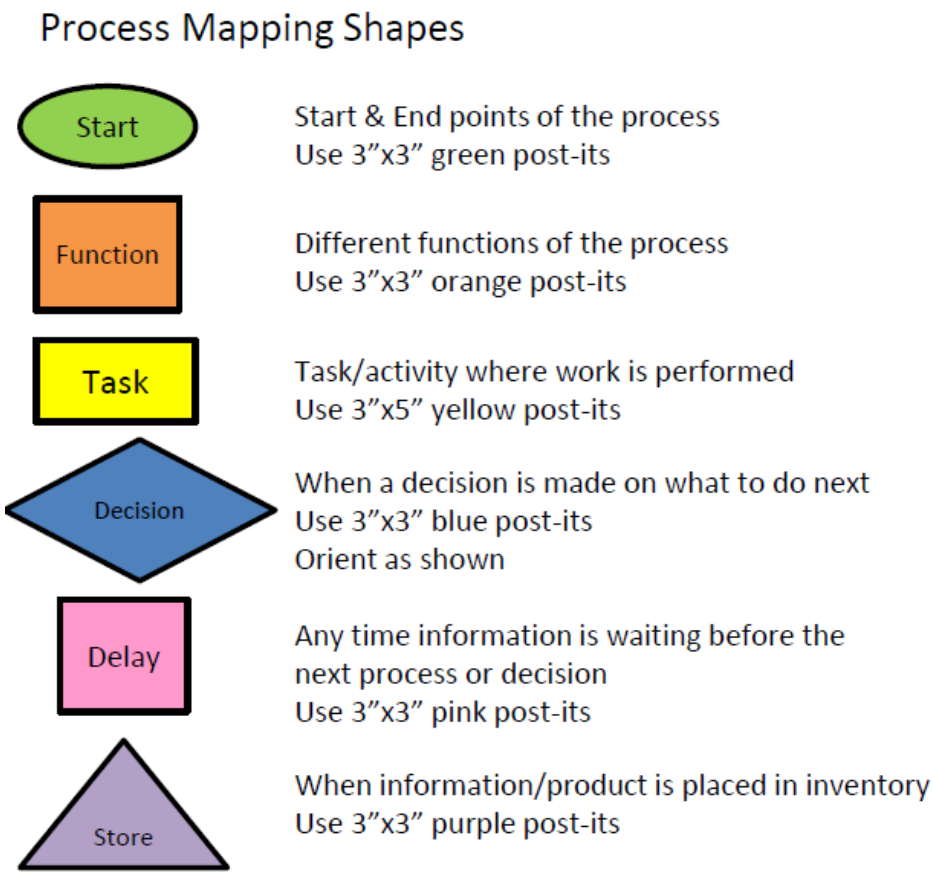
Tool 4.1: Process Maps

A process map is a planning tool that visually shows the flow of a work process.

Why would you use a Process Map?

Process mapping improves efficiency and provides a clear picture into a process. A process map helps teams brainstorm ideas for process improvement. They increase communication and provide process documentation. Process mapping will identify bottlenecks, approvals issues, wasted steps, and mistakes.

- Process maps can be very detailed or very high level as needed
- They allow teams to picture the work being done in other agencies or departments
- They will help you later develop a SIPOC (**S**uppliers, **I**nputs, **P**rocess, **O**utputs, and **C**ustomer) diagram
- If you wish to use a standard set of colors for all your process mapping you can use these for consistency on your process maps:



Step by Step: How to Do a Process Map

1. Identify the process you need to map
2. Bring the right team together
    - People who do the work
    - People who can enact change
    - People who do not know the process very well to ask why
3. Gather materials
    - Different colors of sticky notes for different parts of the process
    - Flip chart paper or rolls of butcher block paper to lay out the process mapping on
    - Different colors of pens or markers
4. Decide on a beginning and ending point of your map
5. Assign meaning to the colors of sticky notes
    - Beginning and ending
    - Decision points
    - Steps in the process
    - Delays
    - Any other meanings you need based upon your process and situation
6. Brainstorm all of the steps in your current process
    - Have an open mind
    - Brainstorm all the steps with no negativity, just capture all ideas
    - Don't get bogged down in the details
7. Put the ideas in order
    - Look for gaps or missing information
    - Start identifying decision points between steps
8. Map the process as it happens most of the time and focus on the 80%, do not waste time on the exceptions
9. Map the actual, not the ideal

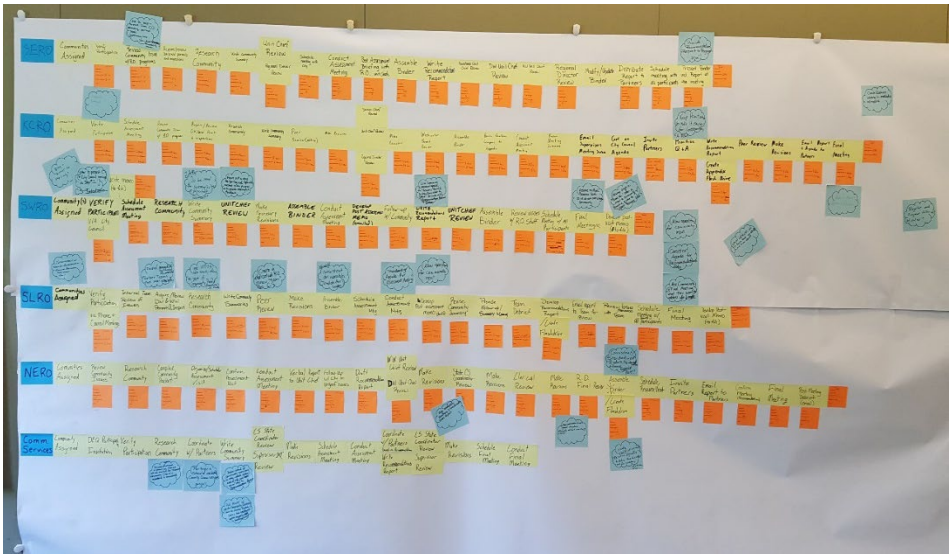


Photo provided by Missouri Department of Conservation

10. Once the process has been placed on sticky notes and placed on paper, draw arrows to show the flow of work
11. This is a good time to note suspected causes of bottlenecks, approvals, wasted steps, or mistakes to revisit later
12. Step back and ask why steps are done in that way or in that order
13. Use the root cause analysis to ask why (refer to A3 method of 5 Whys, Cause & Effect or Fishbone Analysis)
14. Keep for later use
15. Get your Operational Excellence leader involved if you have any questions

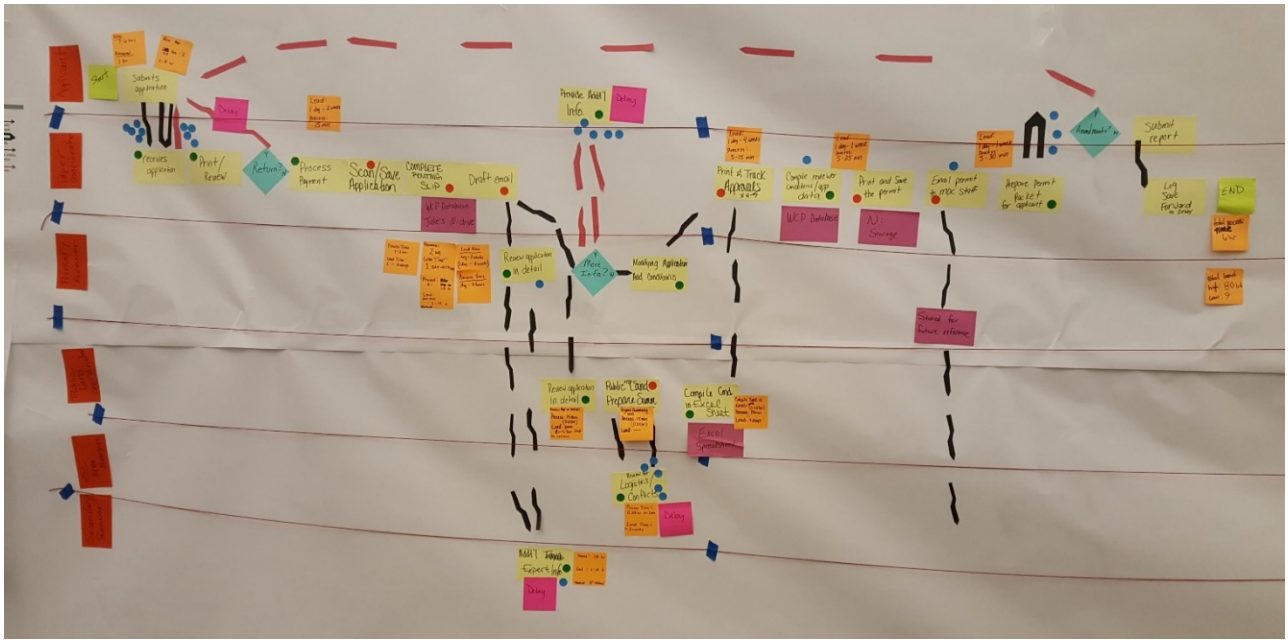


Photo provided by the Missouri Department of Natural Resources

Swim Lane Process Map

A Swim Lane Process Map shows all the steps in a process and assigns those steps to a person responsible. This is helpful when you have a process that switches between people or departments. Some things that you may want to put on each one of the steps:

- VA – **V**alue **A**dded for the customer
- NVA – **N**on-**V**alue **A**dded for the customer
- BNVA – **B**usiness **N**on-**V**alue **A**dded for the customer (regulations, statutes, policies…)
- Time it takes for each step
- Always include if there is wait time in your process

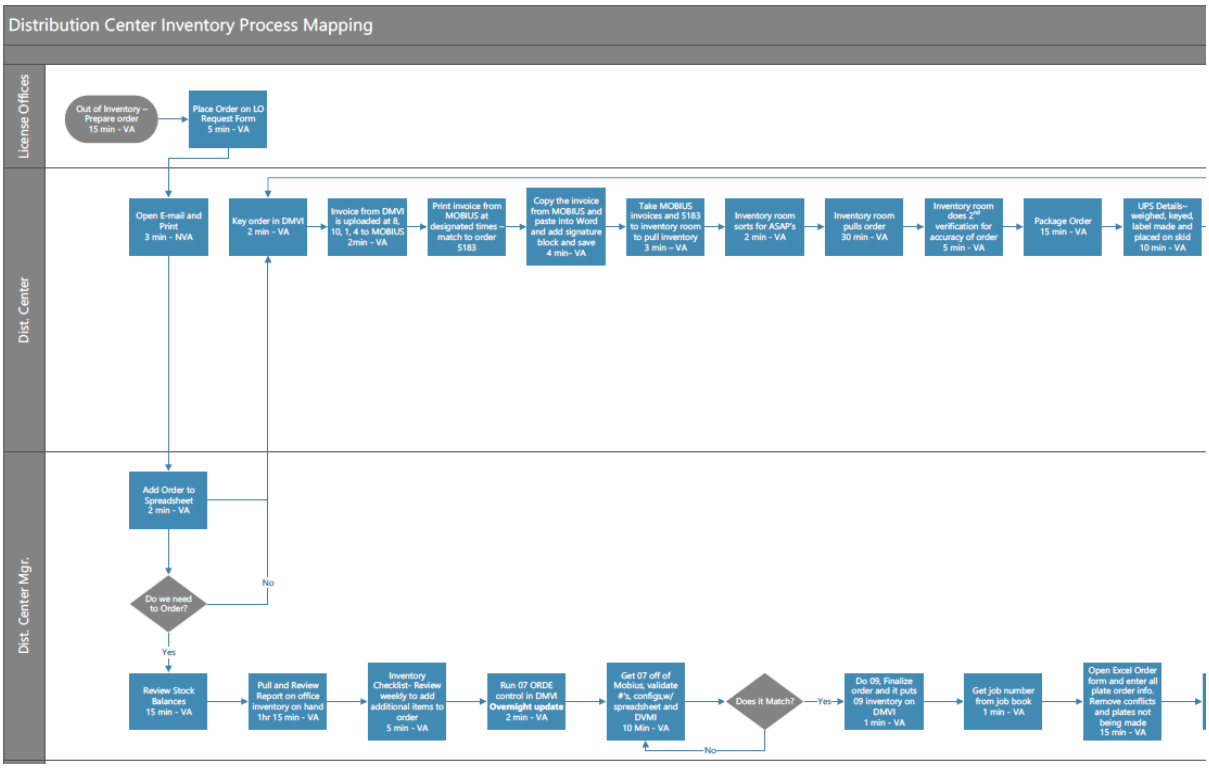
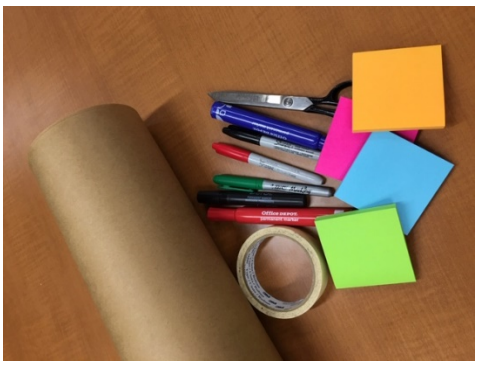


Photo provided by the Missouri Department of Revenue

- Be very specific about where the process starts and where the process ends. The starting and ending steps in the process should align with the scope of your project
- If you are unsure about the steps, ask someone who does the process, or go and watch the process being done
- Keep it simple, do not get bogged down with making it look good. Simple tools are the easiest to use
- Use the process map to help others understand the process, and once a new process map is done of the new process, use it as a training tool
- Dedicate time to process map the entire process in one meeting if possible

Checklist before creating a Process Map:

- ☐ Decide on the process to be mapped
- ☐ Set up a meeting with the key team members to create the process map
- ☐ Gather supplies
  - Different color sticky notes
  - Different color pens and markers
  - Tape
  - Scissors
  - Large wall, paper, or board
- ☐ Find a space with large walls and limited interruptions
- ☐ Decide what color of sticky notes stands for different actions
  - Start and end of process
  - Decision points – turned on the side for diamonds
  - Steps in the process
  - Delays
  - Others as needed
- Choose someone to lead the discussion



Additional Process Map Resources

- Process Map instructional videos on MOLearning
  - Richard Chua: Six Sigma Foundations (How to Map the Current Process)

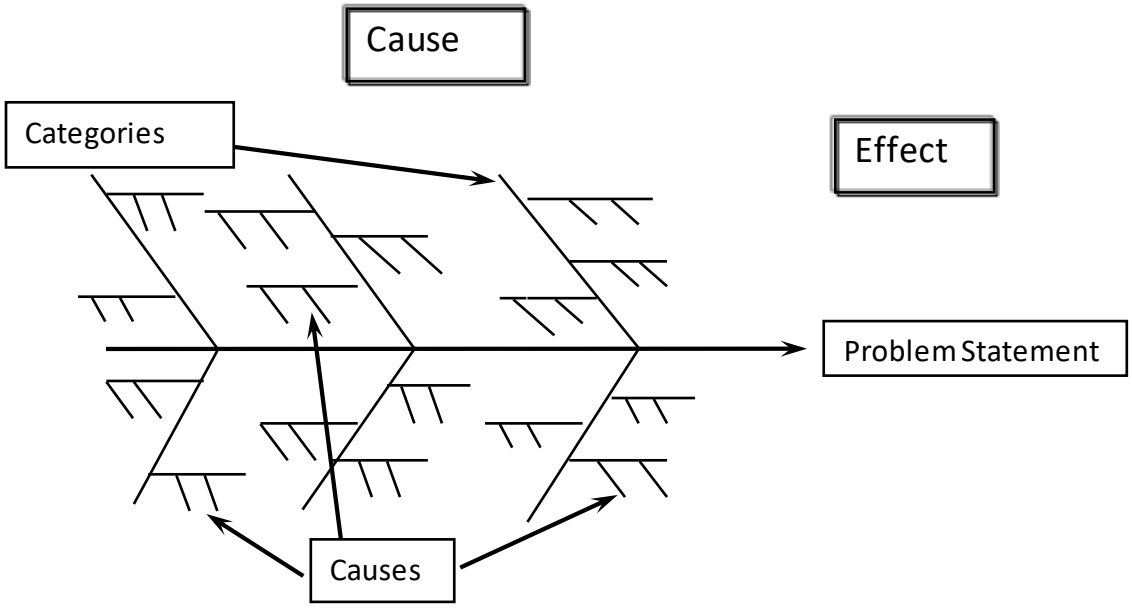
Richard Chua: Operational Excellence Foundations (Process Mapping)

Tool 4.2: Cause and Effect Diagram (Fishbone Diagram)

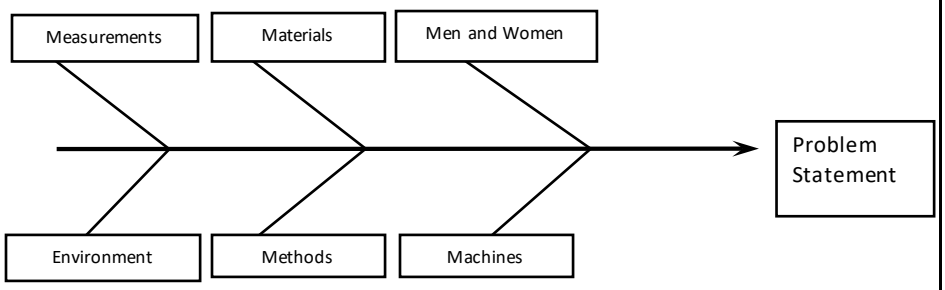
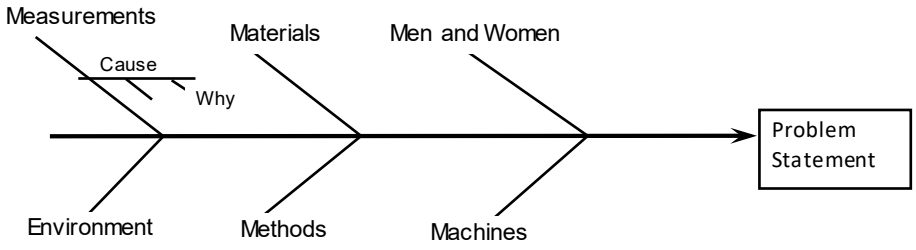
Description A visual display of all possible causes of a specific problem

Purpose Allows a team to identify, explore and graphically display, in increasing detail, all of the possible causes related to a problem or condition to discover its root cause(s).

Blank Diagram



Procedure Follow the steps in the chart below to create a Cause and Effect Diagram

Step	Action
1	Draw a blank diagram on a flip chart
2	Define your problem statement. Make sure team agrees. Include as much information as possible on the "what", "where", "when" and "how much" of the problem. Use data to specify the problem.
3	Label branches with categories appropriate to your problem  Categories can also be the 4 Ps (Policies, Procedures, People and Plant) or any other category that will help people think creatively.
4	Brainstorm possible causes and attach them to appropriate categories
5	For each cause ask, "Why does this happen?" 
6	Analyze results (any causes repeat?)
7	As a team, determine the three to five most likely causes.
8	Determine which likely causes you will need to verify with data. Gather data through check sheets or other formats to determine the relative frequencies of the different causes.

Step 5.0: How can we solve for the root causes?

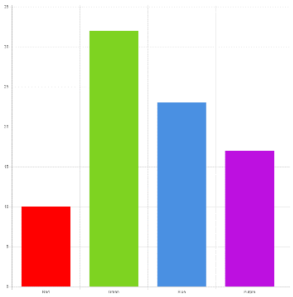
There are various ways to identify root causes. One of the more common methods is using a cause and effect diagram (see below for further details). Another method is asking the 5 whys. There may be multiply root causes to your problem. Often you may implement several solutions to knock down the problem. One consideration is the cost/benefit of the solution. You want to make sure the cost of the solution does not outweigh the benefits you will receive.

Tool 5.1: Graphical Analysis

Now that you have mapped the process, the next step is to visually display the information you have about the process. Data is analyzed in more than one way. Graphical and statistical analysis are part of the Six Sigma process. Graphical Analysis provides clarity and objectivity to data. After all, a picture is worth a thousand words!

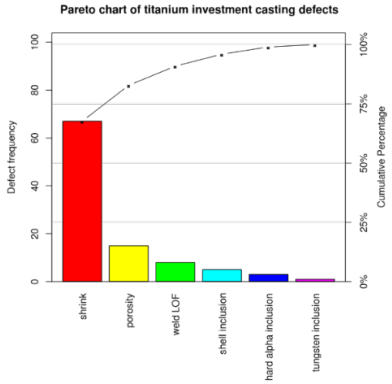
Graphs are visual displays of quantitative data. They lay out, describe or summarize a set of numbers or statistics. They visually display complex data and help the team interpret data. Excel is commonly used to create the graph, and then transferred to your presentation document. Examples of graphical analysis are:

- Bar chart – graphically compares quantities by rectangles (bars) of equal widths but of heights proportional to the quantities being represented. A bar chart compares collected data in a visual representation. It is used as a data display visual aid, especially when comparing quantities. It makes data demographics about X variables visible.



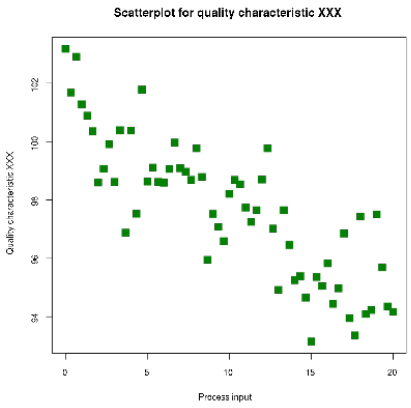
- Pareto chart – A Pareto chart organizes data to show the major factor(s) that make up the subject being analyzed. It is used to display information about the X's (cause) that influence the Y (effects). The bars in a Pareto chart are arranged side by side in descending order from the left. The basis for Pareto analysis is the "80-20 rule"; 80% of the problems result from 20% of the causes.

  A Pareto Analysis is used to identify major factors in a subject being analyzed. First, identify the important X variables that influence the Y variables. Then display the information regarding suspect variables. Next, you prioritize the variables, and identify problems in the current situation analysis.



- Scatter diagram – A scatter diagram is a tool that shows the relationship between two variables plotted on a graph with an X and Y axis. A scatter diagram can be used to verify a root cause identified through cause-end-effect analysis. Some examples of variables with possible relationships are:
    - Hours worked and production output
    - Age and blood pressure
    - Speed and gas consumption

  A scatter diagram is used to examine potential root causes. Take care in plotting a scatter diagram to ensure a relationship exists.



  The graphical tools can be used throughout the Lean Six Sigma methodology to:
    - Further refine a problem statement
    - Stratify the data
    - Investigate potential cause and effect relationships
    - Focus team activity

  Graphs and charts are graphical representations of data that help to clarify the data, indicate trends, and aid in the evaluation of data.

Tool 5.2: Failure Modes and Effect Analysis (FMEA)

Description An FMEA is a structured approach to:

- Identify the ways in which a process can fail to meet critical customer requirements
- Estimate the risk of specific causes with regard to these failures
- Evaluate the current control plan for preventing these failures from occurring
- Prioritize the actions that should be taken to improve the process

Purpose

- Improves the quality, reliability and safety of products
- Helps to increase customer satisfaction
- Reduces product development timing and cost
- Documents and tracks actions taken to reduce risk

Types Refer to the table below for descriptions of the types of FMEAs.

Type	Description
System FMEA	Used to analyze systems and subsystems in the early concept and design stages.
Design FMEA	Used to analyze products before they are released to production.
Process FMEA	Used to analyze manufacturing, assembly and transactional processes.

Terminology The table below defines terms you should know to create an FMEA.

Term	Definition
Failure Mode	The manner in which a part or process can fail to meet specification. Usually associated with a defect or nonconformance. Also referred to as the "in-process" defect.
Cause	A deficiency that results in a failure mode. Causes are sources of variability associated with key process input variables.
Effect	The impact on the customer or customer requirements if the failure mode is not prevented or corrected. The customer can be downstream or the ultimate customer.

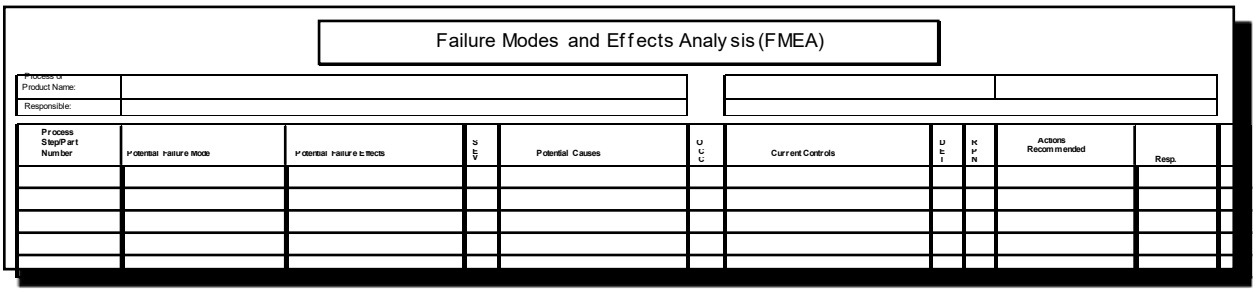
Calculations Refer to the following table for definitions of the calculations in an FMEA. All scales are from 1 to 10. Lower numbers are always good and higher numbers are always bad. See attachments section for further details on scales.

Term	Definition
Severity Risk (SEV)	The significance of the impact of the effect to the customer (internal or external)
Occurrence Risk (OCC)	The likelihood of the failure mode to occur
Detection Risk (DET)	The likelihood that the current system will detect the cause or failure mode if it occurs
Risk Priority Number (RPN)	A numerical calculation of the relative risk of a particular failure mode. RPN=SEV x OCC x DET. This number is used to place priority on which items need additional quality planning

Before you Begin Complete the steps in the table below before completing the FMEA chart.

Step	Action
1	Select process team
2	Develop process map and identify process steps
3	List key process outputs to satisfy internal and external customer requirements
4	List key process inputs for each process step
5	Define matrix relating product outputs to process variables
6	Rank inputs according to importance

Format



Process Follow the steps below to complete the FMEA chart.

Step	Action
1	List the process steps or product parts
2	List failure modes for each process step
3	List the effect of each failure mode
4	Rate the severity of the effect to the customer (Refer to attachments section for ratings scale)
5	List the causes for each failure mode. Each cause is associated with a process input out-of-spec
6	Rate how often a particular cause or failure mode occurs (Refer to attachments section for ratings scale)
7	Document how well the cause is currently being controlled in the process
8	Rate how well the cause or failure mode can be detected (Refer to attachments section for ratings scale standards)
9	Calculate the RPN
10	Use the RPNs to select high priority failure modes. Document plans to reduce or eliminate risks. An improvement plan is required when the RPN exceeds 120
11	Designate who is responsible for action and project completion date
12	Recalculate the RPN when improvement action is completed

Related Resources The Book of Knowledge has the following additional topics to assist in creating a FMEA.

- When is an FMEA started?
- Who prepares an FMEA?
- When is an FMEA updated**?**
- Who updates an FMEA?
- When is an FMEA completed?

Standardization of Ratings

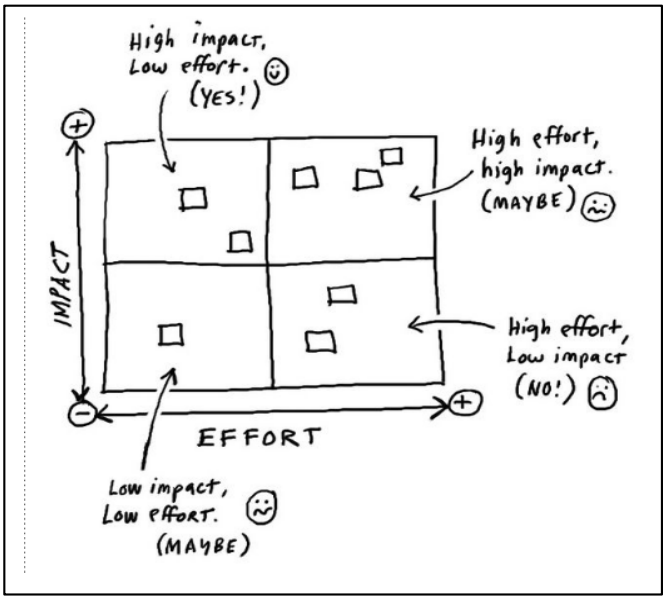
RATING	DEGREE OF SEVERITY	LIKELIHOOD OF OCCURRENCE	ABILITY TO DETECT
1	Customer will not notice the adverse effect or it is insignificant	Likelihood of occurrence is remote	Sure that the potential failure will be found or prevented before reaching the next customer
2	Customer will probably experience slight annoyance	Low failure rate with supporting documentation	Almost certain that the potential failure will be found or prevented before reaching the next customer
3	Customer will experience annoyance due to the slight degradation of performance	Low failure rate without supporting documentation	Low likelihood that the potential failure will reach the next customer undetected
4	Customer dissatisfaction due to reduced performance	Occasional failures	Controls may detect or prevent the potential failure from reaching the next customer
5	Customer is made uncomfortable or their productivity is reduced by the continued degradation of the effect	Relatively moderate failure rate with supporting documentation	Moderate likelihood that the potential failure will reach the next customer
6	Warranty repair or significant manufacturing or assembly complaint	Moderate failure rate without supporting documentation	Controls are unlikely to detect or prevent the potential failure from reaching the next customer
7	High degree of customer dissatisfaction due to component failure without complete loss of function. Productivity impacted by high scrap or rework levels.	Relatively high failure rate with supporting documentation	Poor likelihood that the potential failure will be detected or prevented before reaching the next customer
8	Very high degree of dissatisfaction due to the loss of function without a negative impact on safety or governmental regulations	High failure rate without supporting documentation	Very poor likelihood that the potential failure will be detected or prevented before reaching the next customer
9	Customer endangered due to the adverse effect on safe system performance with warning before failure or violation of governmental regulations	Failure is almost certain based on warranty data or significant DV testing	Current controls probably will not even detect the potential failure
10	Customer endangered due to the adverse effect on safe system performance without warning before failure or violation of governmental regulations	Assured of failure based on warranty data or significant DV testing	Absolute certainty that the current controls will not detect the potential failure

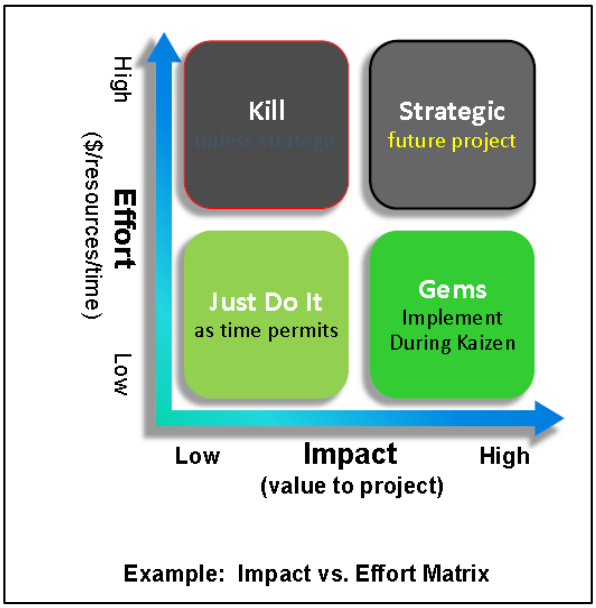
Numerical Ranking	OCCURRENCE (Likelihood)	DETECTION (Certainty)
1	1 in 10	100%
2	1 in 20,000	99%
3	1 in 5,000	95%
4	1 in 2,000	90%
5	1 in 500	85%
6	1 in 100	80%
7	1 in 50	70%
8	1 in 20	60%
9	1 in 10	50%
10	1 in 2	<50%

Step 6.0: How can we experiment with our ideas?

After you have identified the root cause(s) to the problem, you will need to identify ways to fix it or actions to reduce or eliminate the root cause(s). Start by brainstorming with your team and develop actions and/or countermeasures to address the problem. In order to focus in on the most impactful countermeasures, conduct an Impact vs Effort Matrix to help determine the value of each countermeasure.

Tool 6.1: Impact/Effort Chart





Example: Impact vs. Effort Matrix

How to do an Impact/Effort Chart

1. Write countermeasure on a sticky note. Consider:
    - Will it solve the problem?
    - Show linkage to the root cause
2. With your team, determine level of effort (resources/time) and impact.
    - High impact/low effort — Means: Yes! Implement.
    - High impact/high effort — Means: Likely to implement. It's a maybe.
    - Low impact/high effort — Means: No.
    - Low impact/low effort — Means: Likely to implement. It's a maybe.
3. Place sticky on chart rating each one accordingly.
4. Step back and analyze the results.
    - Identify countermeasures by priority

Tool 6.2: Prioritization

There are different methods and variables that are used to prioritize solutions. An easy way to prioritize is N/3. N refers to the total population of possible causes or solutions under consideration. If you divide the total population by 3, this refers to the number of choices each participant has. For example, if the population is 12, then the total choices by each participant would be 4. The group can decide if participants can use all 4 of their choices on one selection.

Phase: Sustain

Step 7.0: What is our plan to implement?

Now that we have validated that our solution(s) will give us the capability, we need to meet our customer's requirements, it is time to implement these solutions.

Tool 7.1: Project Plan

- Owner
- Goal
- Identified impact
- Implementation timeline
- Target/expected amount of change
- Actual amount of change
- Status measure(s)

It's helpful to track countermeasures in a Gantt chart or similar diagram to show actions/outcomes, timeline, and responsibilities. As data rolls in, review the outcomes often (weekly/bi-weekly) during huddles and compare to the gap analysis:

- Are you closing the gap? If so, you can likely forge ahead.
- Is the gap getting larger and targets will be missed? If so, revisit the scope of the project as it may be just a matter that you will need more time to have the intended impact.

Knowing when to adjust the scope so you achieve goals and targets is very important to success!

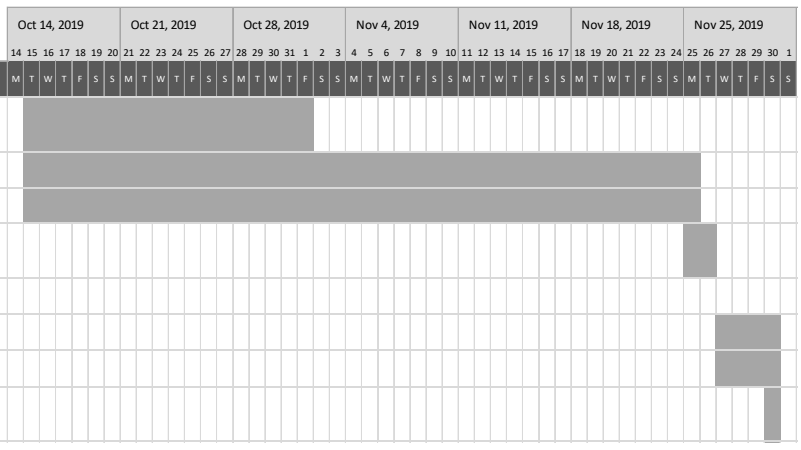
Tool 7.2: Gantt Chart

Keep on Truckin'

Missouri Department of Revenue
Project Lead

Project Start: Tue, 10/15/2019
Display Week: 1

TASK	ASSIGNED TO	PROGRESS	START	END
Notice to License Office tha updated Commercial Driver License (CDL) video and instructions forthcoming	Name	100%	10/15/19	11/1/19
Update CDL training video		100%	10/15/19	11/25/19
Update CDL training material		100%	10/15/19	11/25/19
Motor Vehicle and Driver License Leadership approves video and material		100%	11/25/19	11/26/19
Deployment to License Offices				
Post video to License Office intranet page		100%	11/27/19	11/30/19
Post training material to License Office intranet page		100%	11/27/19	11/30/19
License Office Bureau sends email to all License Offices notifying them of the video and material		100%	11/30/19	11/30/19



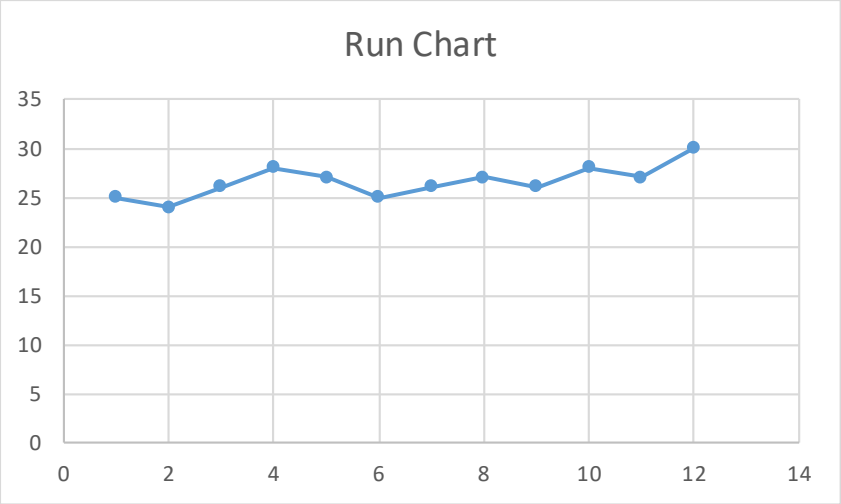
Step 8.0: What are the results?

Collect and analyze results and outcomes from each countermeasure. Did it have the intended impact? If yes, by how much, and is the needle moving toward the future state? If no, why not? If yes, what is the probability we will sustain in the next 30 days, 60 days, 90 days, or year(s)?

Throughout your project, remind yourself and your team that you/we are in a constant state of "Plan, Innovate, Sustain." Remember to review and reiterate DMAIC at each step.

Tool 8.1: Revised Run Chart

A revised run chart is simply the results plotted as data points over a period of time once a solution has been implemented. The chart should reflect less variance and the process would be considered as stable. A stable process generally leads to more predictability. Depending on the frequency of the activity, more data points is generally better, you should have a minimum of three data points before you can draw any conclusions.



Tool 8.2: Feedback Survey

Select an appropriate method for collecting customer feedback on changes to the process, and their experience with it.

Step 9.0: What are our lessons learned?

Review the entire project with the team and discuss:

- What went well?
- Did we accomplish the "desired state"?
- Did we exceed our goals or just meet them?
- What could we have done better?
- What will we do differently next time?

Revisit the desired state and determine next steps as needed.

Tool 9.1: Plus/Delta

+	
What did we like about the process?	What needs to change about the process?

Tool 9.2: Celebrate

Celebrate the improved processes with your team.