

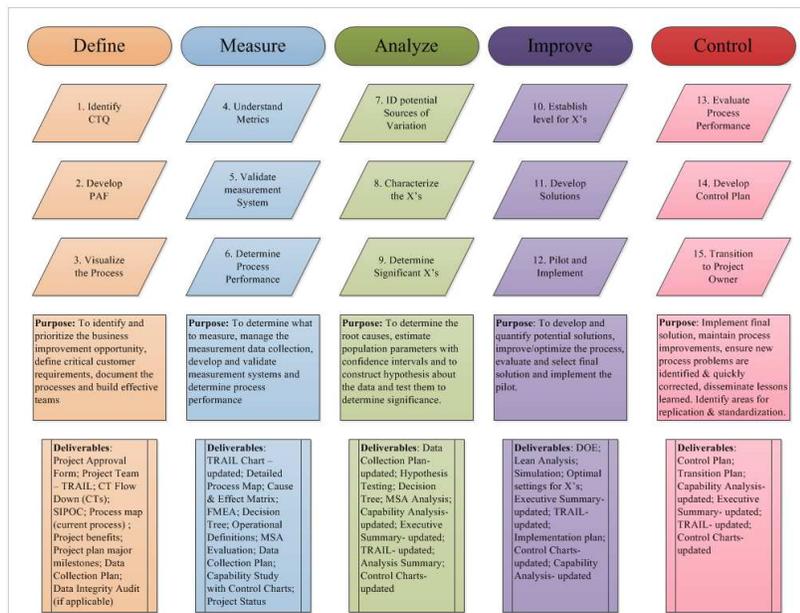
# LeanOhio Green Belt: Transforming the Public Sector

Week Two

Cause and Effect  
Matrix

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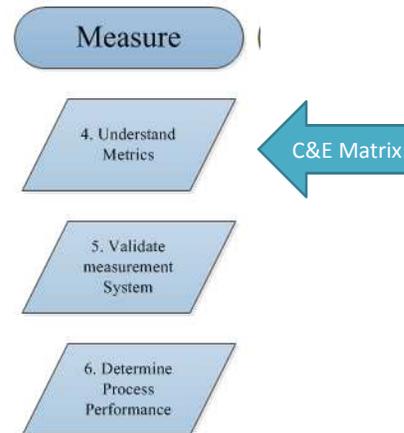
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## DMAIC Flow

- Measure
  - Understand Metrics
  - Validate Measurement System
  - Determine Process Performance

Purpose: To determine what to measure, manage the measurement data collection, develop and validate measurement systems and determine process performance.



## The First Two Mantras

❖ Y is a function of X

❖ Variation is EVIL

## Inputs and Outputs

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## Understanding Inputs & Outputs

- Y's (outputs) are impacted by X's (inputs)
- Through use of analytical methods, we will understand how various inputs cause the process (outputs) to behave.
  - First we must identify the inputs and outputs that are key to the process
- There are several basic methods for identifying key process characteristics:
  - Process Mapping (including SIPOC)
  - Variables Process Mapping
  - C&E Matrix

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## Output Variables

- Products, services, or information can all be *outputs* of a process.
  - The measurable “results” of the process are referred to as output variables.
  - Why “variables”? Outputs change as a result of process variation; we are measuring the key characteristics of the outputs.
- Output variables = **“Y” variables**

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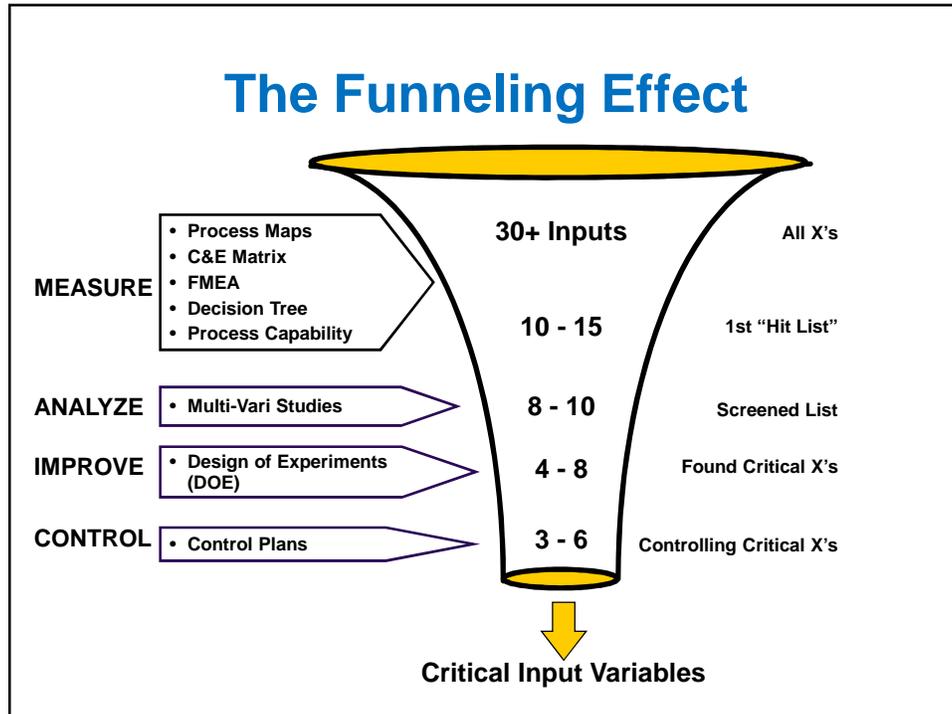
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## Input Variables

- Factors that affect a process and the process’ outputs are called *inputs*.
  - The measurable “inputs” on the cause side of the process are called input variables.
  - When inputs change, it can cause the process to change (ultimately impacting the outputs)
- Input variables = **“X” variables**

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## Classifying Input Variables

Classifications for input variables include:

### Controllable (C):

- can be changed to see the effect on Y;
- sometimes called "Knob" Variables

### Uncontrollable (U):

- impact the Y but are difficult or impossible to control;  
ex: environmental variables such as humidity;
- may be controllable by something/ someone else  
(output of another process);
- sometimes called "Noise" variables

## Classifying Input Variables

### Standard Operating Procedure:

- change only possible by means of a procedural change;
- variable is considered “constant” when the procedure is unchanged and always followed

### Critical Key Inputs:

- statistically shown\* to have a major impact on the variability of the Y;
- designation is added during the Analyze and Improve Phases when appropriate

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## Risk Assessment Tools

- Risk Assessments evaluate the magnitude that potential events might have on an organization’s ability to achieve both its strategic and operational objectives.

There are three Six Sigma tools that can be used to translate the historically qualitative approach to more quantitative methods.

- Cause-and-effect matrix
- Risk matrix
- Failure mode and effects analysis (FMEA)

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## Cause and Effect Matrix

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## Cause and Effects Matrix

- Used to emphasize the importance of understanding customer requirements
  - Also known as a “Prioritization Matrix”
- Outputs are rated based on importance to the customer
- Inputs are scored based on relationship to outputs
- ❖ High scoring inputs are carried over to FMEA
- ❖ Results used in Capability Study
- ❖ Results used in Process Control Plan

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## SIPOC: DOP Case Study

Supplier	Input	Process	Output	Customer
Agency	Continue Ed transcript	<b>Application is Received</b>	Approved Plan	Agency Legislature
Applicant	Application	<b>Application is Reviewed</b>	Info reported to OBM	DOP Staff Taxpayer
Consumer	Supporting Docs	<b>Supporting Docs Reviewed</b>	Info reported to OAKS	Legal
OBM Legislature Legal	Audit Results Emails Mail	<b>Additional supporting docs requested and reviewed</b>	Scanned Documents Dismissal Approval Email/Letter	Legislature
OAKS	Budget	<b>Decision issued to application</b>	DOP Database	

## The Cause & Effect Matrix Template

Cause and Effect Matrix												
		Rating of Importance to Customer										
		1	2	3	4	5	6	7	8	9	10	
Process Step	Process Inputs											Total
		1										
2												0
3												0
Total		0	0	0	0	0	0	0	0	0	0	
		Lower Spec										
		Target										
		Upper Spec										

## Cause & Effect Matrix Steps

- List project Y's / key outputs from your SIPOC
- Set priority factor for each output based on importance to customer
  - Scale of 1 to 10: higher scores for more important factors
- List all process steps / inputs
- Determine correlation of each input to each output
  - Low correlation: changes in the input variable (amount, quality, etc.) have small effect on output variable
  - High correlation: changes in the input variable greatly affect the output variable
- Cross multiply correlation values with priority factors and sum for each input

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## Relating Inputs to Customer Requirements

- Correlation scores: 4 levels – 0, 1, 3 and 9
  - **0** = No Correlation
  - **1** = Input only remotely affects the customer requirement
  - **3** = Input has a moderate effect on the customer requirement
  - **9** = Input has a direct and strong effect on the customer requirement
- Assigning correlation takes the most time

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# Cause & Effect Matrix

1. List Key Outputs and/or CTQs

Cause and Effect Matrix

		Cause and Effect Matrix													
		Rating of Importance to Customer													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement							
Process Step	Process Inputs														
1															
2															
3															

# Step 1 Example

1. List Key Outputs and/or CTQs

Cause and Effect Matrix

		Cause and Effect Matrix													
		Rating of Importance to Customer													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Approved Plan	Info to OBM	Info to OAKS	Scanned Docs	Approval Letter	Approval Email	DOP Database							
Process Step	Process Inputs														

# Cause & Effect Matrix

Cause and Effect Matrix									
	Rating of Importance to Customer	1	2	3	4	5	6	7	
		Requirement							
Process Step	Process Inputs								Total
1									#REF!
2									#REF!
3									#REF!
4									#REF!
5									#REF!

2. Rate Outputs as to Customer importance

# Step 2 Example

Cause and Effect Matrix									
	Rating of Importance to Customer	10	2	2	1	3	9	1	
		1	2	3	4	5	6	7	
Process Step	Process Inputs	Approved Plan	Info to OBM	Info to OAKS	Scanned Docs	Approval Letter	Approval Email	DOP Database	Total
1									#REF!
2									#REF!

2. Rate Outputs as to Customer importance

## Cause & Effect Matrix

**3. List High Level Process Steps**

Cause and Effect Matrix									
		Rating of Importance to Customer							
		1	2	3	4	5	6	7	
		Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	
Process Step	Process Inputs	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Total
1									#REF!
2									#REF!
3									#REF!
4									#REF!
5									#REF!
6									#REF!

## Step 3 Example

**3. List High Level Process Steps**

Cause and Effect Matrix									
		Rating of Importance to Customer							
		9	3	3	0	3	9	0	
		1	2	3	4	5	6	7	
		Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	
Process Step	Process Inputs	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Total
Application is Received									#REF!
Application is Reviewed									#REF!
Supporting Docs Reviewed									#REF!
Additional Supporting Docs Requested									#REF!
Decision Issued to Application									#REF!

# Cause & Effect Matrix

**4. List Inputs by Process Step**

**Cause and Effect Matrix**

		Rating of Importance to Customer							
		1	2	3	4	5	6	7	
		Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	
Process Step	Process Inputs								Total
1									#REF!
2									#REF!
3									#REF!
4									#REF!
5									#REF!
6									#REF!

# Step 4 Example

**4. List Inputs by Process Step**

**Cause and Effect Matrix**

		Rating of Importance to Customer							
		1	2	3	4	5	6	7	
		Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	
Process Step	Process Inputs								Total
1	Application is Received	Application							#REF!
2		Contact Information							#REF!
3	Application is Reviewed	Continuing Ed							#REF!
4		Supporting Docs							#REF!
5		Budget							#REF!
6	Supporting Docs Reviewed	Audit Results							#REF!
7	Additional Supporting Docs Requested								#REF!
8	Decision Issued to Application	Agency Contact							#REF!

# Cause and Effect Matrix

5. Relate Inputs to Outputs

Cause and Effect Matrix

		Rating of Importance to Customer							
		1	2	3	4	5	6	7	
		Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	
Process Step	Process Inputs								Total
1									#REF!
2									#REF!
3									#REF!
4									#REF!
5									#REF!
6									#REF!
7									#REF!
8									#REF!

# Step 5 Example

5. Relate Inputs to Outputs: 0, 1, 3 and 9

		Rating of Importance to Customer								
		10	2	2	1	3	9	1		
		1	2	3	4	5	6	7		
Process Step	Process Inputs	Approved Plan	Info to OBM	Info to OAKS	Scanned Docs	Approval Letter	Approval Email	DOP Database	Total	
1	Application is Received	Application	9	3	1	0	1	3	3	#REF!
2		Contact Information	3	0	1	3	9	9	1	#REF!
3		Continuing Ed								#REF!
4	Application is Reviewed	Supporting Docs								#REF!
5		Budget								#REF!
6	Supporting Docs Reviewed	Audit Results								#REF!
7	Additional Supporting									#REF!

This is a subjective estimate of how influential the Inputs are on the Outputs

## Cause & Effect Matrix

		Rating of Importance to Customer							
		1	2	3	4	5	6	7	
		Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Total
Process Step	Process Input								
1									#REF!
2									#REF!
3									#REF!
4									#REF!
5									#REF!
6									#REF!
7									#REF!
8									#REF!

**6. Cross-multiply and prioritize**

**Sum of Rating x Correlational Score values for all Requirements**

## Step 6 Example

		Rating of Importance to Customer															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Total
Process Step	Process Input																
1																	0
2																	0
3																	0
4																	0
5																	0
6																	0
7																	0
8																	0

**(8 x 9) = 72**

### Step 6 continued

		Rating of Importance to Customer															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Total
Process Step	Process Input																
1		9	3														75
2																	0
3																	0
4																	0
5																	0
6																	0
7																	0
8																	0

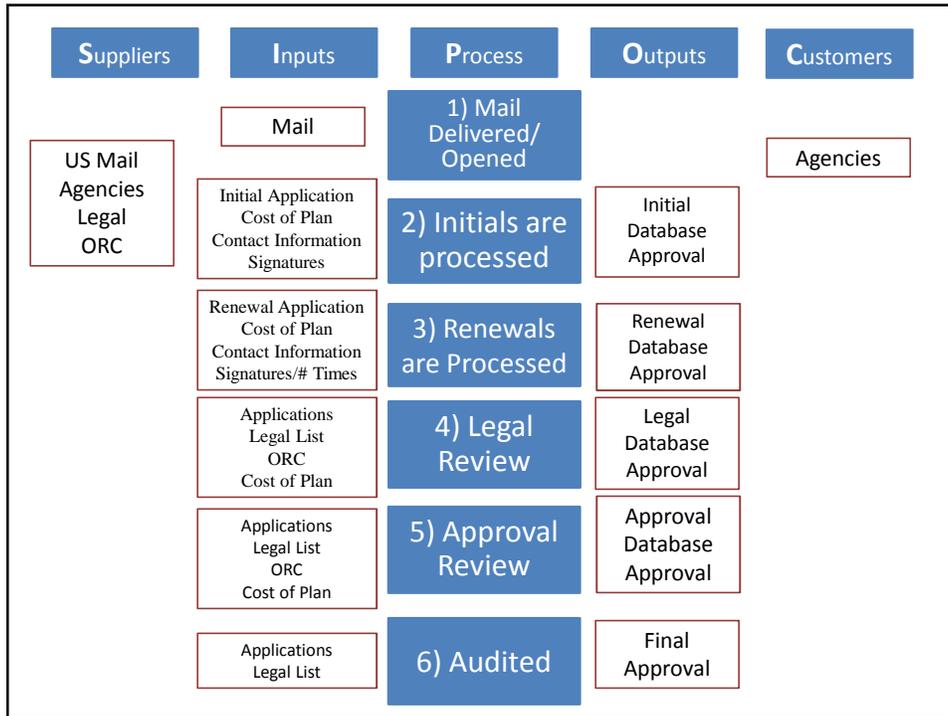
$(8 \times 9) + (1 \times 3) = 75$

### C & E Matrix Complete

6. Cross-multiply and prioritize

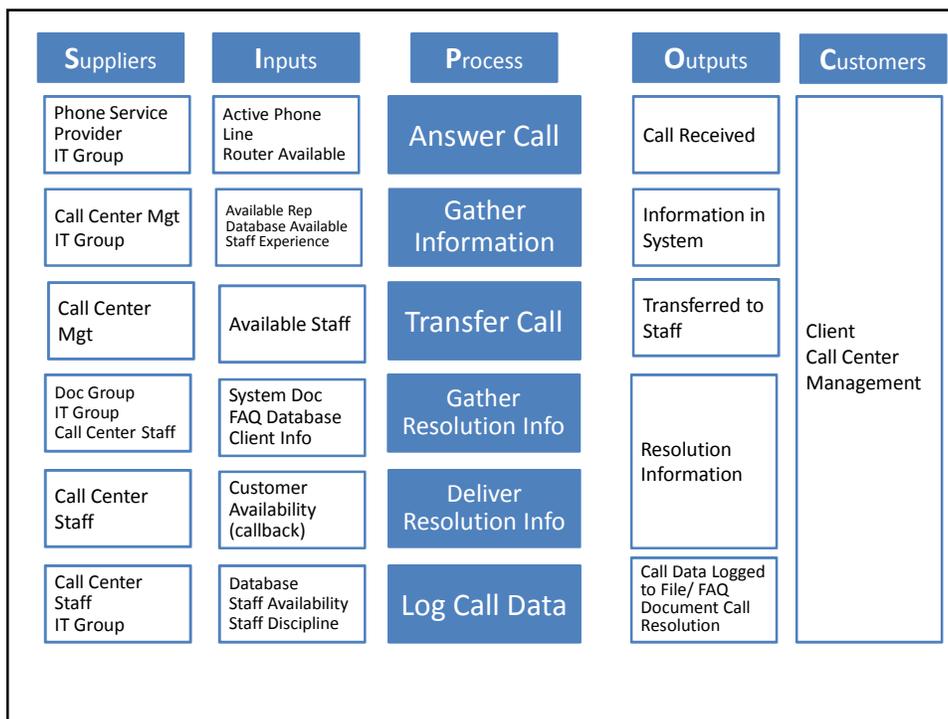
		Rating of Importance to Customer							
		1	2	2	1	3	9	1	
		Approved Plan	Info to OBM	Info to OAKS	Scanned Docs	Approval Letter	Approval Email	DOIP Database	Total
Process Step	Process Inputs								
1	Application is Received	9	3	1	0	1	3	3	131
2	Contact Information	3	0	1	3	9	9	1	144
3	Continuing Ed	3	0	0	0	3	0	0	39
4	Application is Reviewed	9	3	3	9	9	9	9	228

We now start getting a feel for which variables are most important to explaining variation in the outputs



## Activity

- Complete and C&E Matrix for the DOP Example



# Questions

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