Six Sigma Process

Reference document for Project Leaders & Sponsors

Define

Measure

analyze

Improve

Control

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Six Sigma Actors

• **Sponsor & Process Owner**
  • Identify Pain (OGSM)
  • Identify Project leader
  • Support & Resource
  • Follow-up
  • Toll Gate

• **GB**
  • Apply PE / Six Sigma Process
  • Solve Problem
  • Make Recommendations

• **BB**
  • Technical Resource
  • Provide Just in Time Training
  • Cross Functional Projects
  • Intra Franchise & Supplier Project

• **MBB**
  • Training BB
  • Internal Consultant
  • Voice of the Board

• **Functions**
  • Alignment to OGSM
  • Priority
Define Phase

Purpose: “Kill a project”

Define
Measure
analyze
Improve
Control

Six Sigma Process
Steps to follow in Define phase

**Appropriate process to apply for problem solving**
- What is the pain?
- Who is the sponsor?
- Is it a recurring problem?
- What process is delivering the pain?
- How often do we do the process?
- Is it cycle time or inventory only?
  - Yes - Do we do a Lean Mapping?
  - No - Six Sigma Project
- Why do we do this process?
- What are the things that come out of this process that could be measured?
- Who looks at them?

**SIPOC**
- What are things that impact the process outside of the scope of this process?
- Where do I go to measure the inputs?
- What are the 3-8 major groups of activities that change inputs to outputs?
- Can I further focus on one box with the agreement of the sponsor?
- Do I have to do another SIPOC or Process Map for this particular box?
- How does each customer measure the outputs?
- Is that specific & measurable?
- What are the Spec Limits?
- At what point is it bad?
- Which one will I focus first?
- What are the steps in the process from of the view point of the thing going true the process?
  - Does the customer care about each step?
  - Does each step change physically the product?
  - Is it a rework step?
- Is it a JUST DO IT project?
- Can I further focus?
- What resources will I need (time, money & people)?
- Is it X-functional?
- What is the business case? (strategy: customers, share holders, employees, Credo, cost avoidance, etc.)
- When is the deadline?
- Does the sponsor authorize this project?

**VOC / CTQ’s**
- Is it a good project?
Appropriate process to apply for problem solving

1. Business Problem
2. Recurring Problem
   - Yes
   - No
3. Process or Product already exists
   - Yes
   - No
4. Process cycle frequently
   - Yes
   - No
5. Cycle Time / Inventory
   - Yes
   - No
6. Design of Excellence (DMADV)
7. Lean Mapping
8. Output acceptable
   - Yes
   - No
9. Six Sigma (DMAIC)
10. Entitlement acceptable
    - Yes
    - No
11. Conduct Analyze, Innovate, Improve et Control
12. Conduct Define & Measure
13. Assign GB
14. Assign BB
15. End
Prioritization of “JUST DO IT” Projects

The solution is:
1. Evident for everyone, nobody argues.
2. Easy to implement, don’t demand an exhaustive research, development and it is not complex.
3. Reversible. If the result is not what we hope, we can go back like it was before.
4. Low costs.

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Purpose:

1. Why do we do this process?

Suppliers

5. Where do I go to measure the inputs?

Inputs

4. What are things that impact the process outside of the scope of this process?

Process

6. What are the 3-8 major groups of activity that change input to output?

Outputs

7. Can I further focus on one box with the agreement of the sponsor?

Customers

2. What are the things that come out of this process that could be measured?

3. Who looks at them?

8. Do another SIPOC or Process Map of this particular box.
Project Charter

Specific
Measurable
Achievable
Relevant
Timely

CTQ

SIPOC
Stakeholder analysis
Resources

Strategic goals (9 Y’s - OGSM)
Dashboard
Expected Business Results

13 weeks from the start of Measure Schedule
End of Define Phase - Board Presentation

Purpose: Get agreement of the board & leveraging

Agenda:

1 slide
• Sponsor/Project Leader/Team Members
  • Pain
  • Scope / Mission
  • Goal (increase Y - decrease Y)
  • Benefits ($, CREDO, OGSM)

1 slide
• SIPOC

1 slide
• CTQ

1 slide
• Schedule - Deadline

1 slide
• Next Steps

1 slide
• Potential Barriers (optional)

Maximum of 5 to 10 Minutes Strictly enforced

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Measure Phase

Purpose: “Get good process data & set project goal”
### Steps to follow in Measure phase

#### Fishbone &/or SIPOC
- What are my potential X’s (Fishbone & Inputs in SIPOC)?
- Which one are causing variation?
- Which ones will we measure first (quick & easy)?
- How much will it cost to get data?
- How do we know that the measurement system is good enough (page 42 & 43 in pocket guide)?
- What is the sample size?

#### Gage R&R & Data Collection plan
- GET DATA
  - If **CONTINUOUS** data (ex.: temperature, time, pressure, weight, speed, budget, ...)
    - Do I have a minimum of 20 data?
    - Are there obvious typos in data through it?
    - What is the shape (basic statistics - page 74-82) if data is in time order, shift, drift & outlier (Time Series/Individuals)
    - Where is the center & how looks the spread?
    - Any patterns (Boxplots) where I can identify further X’s?
    - If difference, would it be fixable or do I need a new fishbone to identify more X’s?
    - If necessary get more X data
    - What is the baseline sigma (Z), #Bad / Total (method I) or Capability Analysis (method II)?
    - Set goal to 1 sigma above baseline
    - Check with the sponsor
    - If not acceptable, evaluate subgroups
    - Get sponsor agreement
  - If **DISCRETE** data (ex.: good or bad, count, percentage (less than 5 types, Go or No Go...))
    - Do I have a minimum of 60 data?
    - Are there obvious typos in data through it?
    - Pareto and look for 80/20 to further focus or scope down to
      - If no 80/20, regroup
      - If 80/20, scope project & new fishbone
    - If I can scope down, could I measure it continuously?
    - If not, what is the baseline Sigma (Z)? (use method 1 (#Bads / Total))
    - Set goal and check with sponsor, update contract
### Measure Phase Tool Selection

**All:**
- SIPOC
- VOC / CTQ
- Project Charter
- Fishbone
- Measurement System Analysis (R&R)

**Minimum Data I need**

<table>
<thead>
<tr>
<th>Continuous Y</th>
<th>Discrete Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>60</td>
</tr>
</tbody>
</table>

**Continuous X**
- Time Series
- Individuals Chart
- Scatter Plot
- Histogram
- Boxplot

**Discrete X**

<table>
<thead>
<tr>
<th># bads</th>
<th>C-Chart</th>
<th>U-Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>NP-Chart</td>
<td>P-Chart</td>
</tr>
</tbody>
</table>

This tools taught in Control can be use in Measure

**Legend**
- Black = Graphical Tools
- Green = Statistical Charts
- Red = Statistical $P<0.05$
Which X’s to measure

What are my potential X’s?
Which X’s are causing variation?
Which ones will we measure first (quick & easy)?
How much will it cost to get data?

SIPOC

Brainstorm potential Vital Xs

Purpose:

Inputs

Process

Outputs

Customers

Measurements

Materials

Personnel

Environment

Methods

Machines

Measureable Output of Process (Y)

Fishbone from Minitab

Stat>Quality Tools>Cause-and-Effect
Measurement System Analysis

How do we know that the measurement system is good enough?

– **Accuracy** (How do you know data reflect the truth?)
– **Repeatability** (If you were to re-measure, would you get the same answer?)
– **Reproducibility** (If somebody else were to measure, would you get the same answer?)
– **Stability** (has the measure system changed during the period you have gotten your data?)
– **Adequate Resolution** (Is the scale you are using small enough to see variation or change?)

What is the sample size?

**Alternative to Gage R&R**

**Operational Definition:**

Written description or formula of how we measure the output and any tests performed to confirm the measurement system and the accuracy.
Continuous Y Data

Example: temperature, time, pressure, weight, speed, budget, ...

Should have at least 20 data

1- Display descriptive statistics

Minitab: (Stat>Basic Statistics>Display Descriptive Statistics)
- What is the shape of the curve? (see page 74 to 82 in the Six Sigma Pocket Guide)
  - If $P > 0.05$ data are normal
  - If $P < 0.05$ talk to your Black Belt to determine which tools to be used
- Where is the center of the curve?
- How looks the spread?

GOOD SHAPE

BAD SHAPE
Continuous Y Data

Example: temperature, time, pressure, weight, speed, budget, …

Should have at least 20 data

1- Time Series

Minitab: (Graph>Time Series)
- Do I have any shifts, drifts (trend) and outliers?
- If it appears to be, do an Individuals Charts to prove it

Caution

Can only be used is in sequential order
Continuous Y Data

Example: temperature, time, pressure, weight, speed, budget, …

Should have at least 20 data

2- Individuals Chart

Minitab: (Stat>Control Charts>Individuals)
-Use the 8 tests for special causes
Continuous Y Data

2- Boxplot
Minitab: (Graph > Boxplot)
- Any patterns (Boxplots) where I can identify further X’s?
- If difference, would it be fixable or do I need a new fishbone to identify more X’s?
- If necessary get more X data

Example:

Day_o_Wk

Fri Mon Thu Tue Wed

AveAll Hold

0 100 200 300 400

Pattern
Day of week can be one of X-value for this example
Discrete Y Data

Example: good or bad, count, percentage, ...

Should have at least 60 data

1- Pareto (use this type of Pareto to scope and focus)
   Minitab: (Stat>Quality Tools>Pareto Chart)
   - Look for 80/20 to further focus or scope down to

Scope project & new fishbone
could I measure it continuously ?

Regroup

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Discrete Y Data

2- Pareto (use this type of Pareto to see if we need more X data)
Minitab: (Stat>Quality Tools>Pareto Chart)
- Look for 80/20 to further focus or scope down to

Pareto Chart for Retained

Custom

Standard

Kept

Lost

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**Z (Sigma Level) calculation**

**Method I:** (preferred method)

\[
\text{# Bads} \times \frac{1000000}{\text{Total}} = \text{DPMO} \quad \longrightarrow \quad \text{See Z value at p.92 of Six Sigma Pocket Guide}
\]

*Note: can’t be used if we have less than 5 samples of good and 5 samples of bad*

**Process Capability Analysis for Ave All Hold**

<table>
<thead>
<tr>
<th>Process Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>USL</td>
</tr>
<tr>
<td>Target</td>
</tr>
<tr>
<td>Lower Bound</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Sample N</td>
</tr>
<tr>
<td>Std Dev (Within)</td>
</tr>
<tr>
<td>Std Dev (Overall)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potential (Within) Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cp</td>
</tr>
<tr>
<td>CPL</td>
</tr>
<tr>
<td>Cpk</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overall Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pp</td>
</tr>
<tr>
<td>PPU</td>
</tr>
<tr>
<td>PPL</td>
</tr>
<tr>
<td>Ppk</td>
</tr>
</tbody>
</table>

**Observed Performance**

| PPM < LB                | 0.00   |
| PPM > USL              | 931034.48 |
| PPM Total              | 931034.48 |

**Expected "Within" Performance**

| PPM < LB                | 895228.68 |
| PPM > USL              | -930716.26 |
| PPM Total              | 895228.68 |

**PPM = DPMO** \(\longrightarrow\) See Z value at p.92 of Six Sigma Pocket Guide
Answers of Measure Phase Tools

- **Fishbone:** Potential X’s that impact Y
- **Time Series:** Process Shifts, Drifts & Outliers
- **Individuals Chart:** Predictable Process / Common & Special Causes
- **Histogram:** Shape, Center & Spread
- **Boxplot:** Difference in Median and Variation
- **Pareto:** 80/20
End of Measure Phase - Board Presentation

Purpose: Get people focus

Agenda:
1 slide
• Small resume of the Define Phase (Pain, SIPOC, CTQ)
1 slide
• Potential X’s (Fishbone / SIPOC)
1 slide
• Measurement System Analysis
1 slide
• Graphs (Time Series / Histogram / Boxplot / Pareto)
1 slide
• Z baseline / Z Goal
   • Changes to my contract
   • Schedule - Deadline
1 slide
• Next Steps
• Potential Barriers

Maximum of 5 to 10 Minutes
Strictly enforced

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Analyze Phase

Purpose: “Identify what to fix”
Steps to follow in Analyze phase

Type of X & Y Data

- What is the type of the Y’s (continuous or discrete)?
- What is the type of the X’s (continuous or discrete)?
- Do I use the correct tools? (see tool box)
- List of X’s we have data?
  - No data - Process door (process analysis)
  - Benchmark, Expert opinion, Interview
  - Small data sample
  - Use graphical tools in addition to process map
  - Large data sample
  - Use process map, graphical tools & statistical tools

If P-Value of more than 0.05

- If statistical tools
  - if P>.05,
    - No impact
    - Need more data
  - If P<.05, look at R²
  - Power of sample size (Beta)
    - Declare vital X’s
    - Go back and do another fishbone to find more X’s
    - Get different X data
    - Experiment with new X data

Design Of Experiment

- What is the optimum setting?
- What is the main effect?
- Are there interaction?

DOE

- What X’s do we going to fix into Innovate/Improve phase?
## Tool Selection

### Continuous Y

- **20**
- Minimum Data I need

### Discrete Y

- **60**
- This tools taught in Control can be use in Measure

### Continuous X

#### Time Series
- Individuals Chart

#### Scatter Plot
- Regression $R^2$
- Fitted Line Plot $R^2$

### Discrete X

#### Binary Logistic Regression
- Odds

### All:

- SIPOC
- VOC / CTQ
- Project Charter
- Fishbone
- Measurement System Analysis (R&R)

<table>
<thead>
<tr>
<th>Lot Size</th>
<th>Constant</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td># bads</td>
<td>C-Chart</td>
<td>U-Chart</td>
</tr>
<tr>
<td># bads/Total</td>
<td>NP-Chart</td>
<td>P-Chart</td>
</tr>
</tbody>
</table>

### Statistical Analysis

- Black = Graphical Tools
- Green = Statistical Charts
- Red = Statistical $P<0.05$
- Blue = Statistical $R^2$

- Histogram
- Boxplot
- Anova (X bar) $R^2$
- Test of Equal Variances ($\sigma$)
- Main Effects
- Interaction
- DOE $R^2$
- Xbar&R Chart

- Pareto
- Binary Logistic Regression Odds
- Chi-Square

- Minimum Data I need

- This tools taught in Control can be use in Measure
Scatter Plot, Regression & Fitted Line Plot

1 Scatter Plot
Scatter Plot from Minitab
Graph>Plot

Visual relationship between X-Y

2 Regression
Regression from Minitab
Stat>Regression>Regression

Look at your Residual (p. 142)
- If good, look your P-value
- If not, call your Black Belt
Prove the relationship between X-Y
If P<0.05, we can say that this particular X is significantly linear to Y

See page 117 to know if the graph represent a strong, a possible or no correlation between a X and the Y

Continuous Y & Continuous X

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3 Fitted Line Plot

Fitted Line Plot from Minitab
Stat>Regression>Fitted Line Plot

\[ \text{AveAll Hold} = 0.465701 + 0.130845 \times \text{Avg Vol} \]

\( S = 22,6094 \quad R^2 = 86.4\% \quad R^2(\text{adj}) = 86.3\% \)

R\(^2\)-Value means that this particular X explain 86.4% of the percentage of the variation.

Prediction Formula
ANOVA & Test for Equal Variances

1. Analyze of variation

   ANOVA
   ANOVA from Minitab
   Stat>ANOVA>One way
   Prove the variation of averages
   If P<0.05, we can say that averages are significantly different

2. Test for Equal Variances

   Do this test if no difference between averages
   Test for Equal Variances from Minitab
   Stat>ANOVA>Test of Variances
   Prove the variation of Standard Variations
   If P<0.05, we can say that Standard Deviation are significantly different

Continuous Y & Discrete X

Boxplots of Y by Location
(means are indicated by solid circles)

If red dot is not close to the middle line, call your Black Belt

Test for Equal Variances for Y

95% Confidence Intervals for Sigmas

Factor Levels

Colo Hold
SL Hold

F-Test
Test Statistic: 0.257
P-Value : 0.000

Levene's Test
Test Statistic: 42.792
P-Value : 0.000

Boxplots of Raw Data
Chi-Square & Binary Logistic Regression

Chi-Square

Chi-Square from Minitab
Stat>Tables>Cross Tabulation

Prove the variation of rate
If P<0.05, we can say that rates significantly are significantly different

OR

Binary Logistic Regression

Binary Logistic Regression from Minitab
Stat>Regression>Binary Linear Regression

Prove the variation of rates
If P<0.05, we can say that Standard Deviation are significantly different

Discrete Y & Discrete X

Tabulated Statistics: Y Retained; Prod-Type
Rows: Y Retain	Columns: Prod-Typ
Custom Standard	All
Kept 42 6 48
Lost 9 6 15
All 51 12 63
Chi-Square = 5,605; DF = 1; P-Value = 0.018
1 cells with expected counts less than 5.0
Note: P-value of Chi-Square is .018. Therefore there is a significant difference for this particular analyze.

Example in Minitab

See next page
Binary Logistic Regression

Binary Logistic Regression from Minitab
Stat>Regression>Binary Linear Regression

Prove the variation of rates
If P<0.05, we can say that Standard Deviation are significantly different

Example in Minitab

Binary Logistic Regression: Y Retained versus Prod-Type

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value: Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y Retain</td>
<td>15 (Event)</td>
</tr>
<tr>
<td>Kept</td>
<td>48</td>
</tr>
<tr>
<td>Total</td>
<td>63</td>
</tr>
</tbody>
</table>

Logistic Regression Table

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coef</th>
<th>SE Coef</th>
<th>Z</th>
<th>P</th>
<th>Odds Ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-1.5404</td>
<td>0.3673</td>
<td>-4.19</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prod-Typ</td>
<td>1.5404</td>
<td>0.6843</td>
<td>2.25</td>
<td>0.024</td>
<td>4.67</td>
<td>1.22</td>
</tr>
<tr>
<td>Standard</td>
<td>4.67</td>
<td>1.22</td>
<td>17.84</td>
<td></td>
<td>P-Value = 0.025</td>
<td></td>
</tr>
</tbody>
</table>

Test that all slopes are zero: G = 4.991; DF = 1; P-Value = 0.025

Note: Binary Logistic Regression also says that there is a significant difference in this same analyze. In addition, it quantifies the odds \( R^2 \) as being 4.67 times more likely.
Design of Experiments (DOE)

We have to do a DOE when we are not able to find vital X’s

Which factor (X) has the biggest impact visually?

**Main Effect**

![Graph showing the impact of different factors on Weld Strength]

- Continuous Y & Discrete X
- Optimum X

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What to do if no P-Value is under 0.05

<table>
<thead>
<tr>
<th>Truth</th>
<th>Not committed crime</th>
<th>Committed crime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not guilty</td>
<td>NO ERROR</td>
<td>Killer</td>
</tr>
<tr>
<td>Guilty</td>
<td>Innocent in jail</td>
<td>in liberty</td>
</tr>
</tbody>
</table>

Type II Error or Beta Risk
Type I Error or Alpha Risk

Note: Black Belt will help you to analyze Beta Risk.
Answers of Analyze Phase Tools

- **Scatter:** Visual relationship between 2 variables (X-Y)
- **Regression:** Prove (P), quantify (R²) and predict (formula) the relationship between variables (X-Y)
- **Fitted Line Plot:** Quantify (R²), prediction formula and 95% prediction interval of residual variation
- **ANOVA:** Prove the difference of averages & gives R²
- **Test of Variances:** Prove the difference of standard deviations
- **Chi-Square:** Prove the difference in rate
- **Binary Logistic Regression:** Prove the difference in rate and provides estimate of R² (odds)
- **DOE:** Identify optimum, main effect and interaction of X’s
End of Analyze Phase - Board Presentation

Purpose: Get people focus

Agenda:

1 slide  • Small resume of the Define Phase (Pain, SIPOC, CTQ)
1 slide  • List of X’s investigated (P-value and $R^2$-value)
1 slide  • Boxplot of the ANOVA Test
1 slide  • Scatter Plot of the Regression Analysis
1 slide  • Process Map analysis if no data
     • Schedule - Deadline
1 slide  • Next Steps
1 slide  • Potential Barriers

Maximum of 5 to 10 Minutes
Strictly enforced

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Innovate/Improve Phase

Purpose: “How to fix”

Define
Measure
analyze
Improve
Control

Six Sigma Process
Steps to follow in Innovate/Improve phase

Prioritization Matrix
- What are the alternative solutions?
- Do the solutions address the vital X’s identified in Analyze phase?
- Which alternative needs most of the most important CTQ’s the best?
- What is the Return On Investment (ROI)?
- What are the risks assessment with this change?
  - Can we minimize impact?
  - Can we reduce probability of the error?
  - Can we improve the detectability?
- Are the risks acceptable?
  - If no, look at other alternatives or close the project
- Do we need a pilot?
  - Is this a high cost, high risk & leveragable project? (all 3 required)
- What is the pilot plan?
- What were the results?
  - If the results are not acceptable, re-do pilot, choose alternative solutions or close project
- How do we roll this out?
  - What is the training plan?
  - What is the communication plan?
  - What resources are required?
    - What is the timeline?
    - What is the expected cost?
    - Who should be involved?

FMEA
- Are the risks acceptable?
- If no, look at other alternatives or close the project

Implementation plan

How do we fix the vital X’s?
## Solution Prioritization Matrix (PUGH Matrix)

Help to determine which solution is the most valuable in function of all CTQ’s

<table>
<thead>
<tr>
<th>CTQ</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CTQ 1</td>
<td>3</td>
<td>+</td>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTQ 2</td>
<td>5</td>
<td>S</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTQ …</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Weighted Comparison | 3 | -5 | 0 | 0 | 0 | 0 |

Compare current with + Better Alternative
selected alternatives - Worse Alternative
S Same Alternative
## Failure Mode Effect & Analysis (FMEA)

Identify, quantify and reduce the risks associated with change

<table>
<thead>
<tr>
<th>Item-Part / Function</th>
<th>Potential Failure Mode</th>
<th>Potential Effect(s) of Failure</th>
<th>Severity</th>
<th>Potential Cause(s)/Mechanism(s) of Failure</th>
<th>Occurrence</th>
<th>Detection</th>
<th>Recommended Action(s)</th>
<th>Responsibility &amp; Target Completion Date</th>
<th>Action Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Enter a system function using verb/noun format

- Failure mode = loss of function or negative of function
- Consequences on other systems, parts, or people
- From block diagram, determine if/how each element can cause system failure
- Method, test or technique used to detect cause of failure
- Design actions to reduce severity, occurrence and detection ratings.
- System design department and date
- Actions and actual completion date

**Severity of Effect:**

1. None
2. Very Slight
3. Slight
4. Minor
5. Moderate
6. Significant
7. Major
8. Extreme
9. Severe
10. Hazardous

**Occurrence Rating:**

1. Almost Never
2. Remote
3. Slight
4. Moderate
5. High
6. Almost Certain

**Detection:**

1. Almost Certain
2. Very High
3. High
4. Moderate High
5. Low
6. Very Slight

**RPNs Risk Priority Number:**

1. Almost Impossible
2. Very Slight
3. Slight
4. Moderate
5. High
6. Almost Certain

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Pilot

When to pilot?

When we have all of these 3 conditions:
  • High cost
  • High risk
  • Process is leveragable

Steps of Pilot
Use PDCA
  • Plan: Plan the scope
  • Do: Conduct the pilot
  • Check: Analyze results and any unexpected consequences
  • Act: Scale up and roll-out
# Implementation Plan

## What do I need to plan?

- **Timeline (Gantt Diagram)**
- **Resources (time, money and people)**
- **Communication (Roles & Responsibilities)**

<table>
<thead>
<tr>
<th>№</th>
<th>Task Name</th>
<th>Durée</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conceptual</td>
<td>80 jours</td>
</tr>
<tr>
<td>2</td>
<td>Planning and Control</td>
<td>20 jours</td>
</tr>
<tr>
<td>3</td>
<td>Business plan identifying project</td>
<td>5 jours</td>
</tr>
<tr>
<td>4</td>
<td>Define project objective and strategy</td>
<td>5 jours</td>
</tr>
<tr>
<td>5</td>
<td>Identify industry standards</td>
<td>5 jours</td>
</tr>
<tr>
<td>6</td>
<td>Develop preliminary concept</td>
<td>5 jours</td>
</tr>
<tr>
<td>7</td>
<td>Initial planning complete</td>
<td>0 jour</td>
</tr>
<tr>
<td>8</td>
<td>Develop appropriation strategy</td>
<td>5 jours</td>
</tr>
<tr>
<td>9</td>
<td>Develop management model</td>
<td>5 jours</td>
</tr>
<tr>
<td>10</td>
<td>Site Assessment</td>
<td>40 jours</td>
</tr>
<tr>
<td>11</td>
<td>Identify potential sites</td>
<td>10 jours</td>
</tr>
<tr>
<td>12</td>
<td>Define infrastructure requirements</td>
<td>15 jours</td>
</tr>
<tr>
<td>13</td>
<td>Define utility needs</td>
<td>10 jours</td>
</tr>
<tr>
<td>14</td>
<td>Identify project site</td>
<td>5 jours</td>
</tr>
<tr>
<td>15</td>
<td>Assess regulatory and environmental</td>
<td>10 jours</td>
</tr>
<tr>
<td>16</td>
<td>Identify permitting requirements</td>
<td>3 jours</td>
</tr>
<tr>
<td>17</td>
<td>Recommend site</td>
<td>10 jours</td>
</tr>
<tr>
<td>18</td>
<td>Site and planning review</td>
<td>5 jours</td>
</tr>
</tbody>
</table>
End of Improve Phase - Board Presentation

Purpose: Get people focus

Agenda:
- 1 slide  • Small resume of the Define Phase (Pain, SIPOC, CTQ)
- 1 slide  • Solution Prioritization Matrix
- 1 slide  • FMEA
- 1 slide  • Pilot results
- 1 slide  • Implementation planning
  - Schedule - Deadline
  - Next Steps
  - Potential Barriers

Maximum of 5 to 10 Minutes

Strictly enforced
Control Phase

Purpose: “Keep it fixed”
Steps to follow in Control phase

Control Plan

• How you are going to control your vital X’s?
  • If Poke-Yoke, show how
  • If monitoring, show which control charts you are going to use
    • How good is this measuring system?
• Do we need to continue to measure the output?
• Is the measurement system still good enough?
• Can we eliminate unnecessary measurement of this process?
• What is the new process map?
• Are there new work instructions?
• If this process is ISO or FDA controlled, has the appropriate documentation been updated?
• Have we destroyed old documentation?
• Is there any training required?
• How do you know the process has changed as a result of this improvement?
• Has ownership of the new process handed off to the functional leader?
• Is the new process predictable?
  • If we need more data, how long will it take?
• What is the new Sigma level?
• Is the new Sigma level enough for the sponsor or do I want this team to go back and find more X’s?

Results Ownership & Control

• Closure
  • If not complete, does the sponsor want more time spent to the project?
  • Have the outside conditions changed the priority or value of this project?
  • Is the Green Belt is waiting for data, capital, etc.?
• Complete
  • Do we have enough data to show statistical predictability?
• Recognition
  • What is the best to recognize each individual participant for their work?
    • Ideas (public recognition, letter from the management, private dinner, etc.)
  • Has the project documentation been sent to the Master Black Belt?
• Could we use these learning on similar processes in the plant or the division or the company?
• What this the next project this Green Belt is to work on?

How do we keep it fixed?
Control Plan

QC focus on vital X’s
  • List of methods to control vital X’s
    • Mistake proofing (Poka Yoke)
    • Monitoring (control charts)
      • Sampling Plan
      • Measurement System Analysis
      • Data Type Selection
      • Control Chart Selection
  Note: If we can’t do a mistake proofing, we must do monitoring

QA focus on output Y
  • List of methods to assure outputs (Y)
    • Inspected release
    • Control Charts
    • Sigma Level
      • By increasing the sigma level, we need to re-evaluate the sampling plan and do another Measurement system analysis
Mistake Proofing

Prevent the error from causing a defect
Examples:
• 115 volt plug design
• Spell checker
• Diesel VS Gasoline nuzzle size
• Keyway piece to prevent bad adjustment
• Floppy disk can only fit in one way
• Etc.
Control Charts

For C, U, P & NP Charts, only first 4 tests for Special Causes are used.

- Control limits will vary as function of sample size for P-Chart and U-Chart
- Control limits will be stable for C-Chart and NP-Chart because sample size is constant
Documentation

We normally need
• New Process Map
• Update ISO documents if required
  • Work instructions
  • Training
  • QA
  • QC
• Eliminate old documents
Evaluate Results, Transfer ownership & Control

Results:
Prove significant impact of changes from implementation phase
- Control Charts (analyze 8 tests for continuous and 4 tests for discrete data)
- Appropriate Statistical tool (look at P-Value of ANOVA, Test of Equal Variances, BLR or Chi-Square)

Example on a Control Chart to show significant difference

<table>
<thead>
<tr>
<th>Individual Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>100</td>
</tr>
</tbody>
</table>

Date of the implementation

UCL=29.74  Mean=14.30  LCL=-1.133
Evaluate Results, Transfer ownership & Control

Transfer ownership:
Hand off operational responsibility for new process to the process owner
• Include all project material, binders, files and documentation to the process owner.
• True control should be evaluated under operational condition instead of project condition
Control:
Prove statistical predictability of the new process
• Control Charts (analyze 8 tests for continuous and 4 tests for discrete data)

Example on a Control Chart to show new process in control

20 consecutive data in no violation of the 8 rules prove statistical control

Use this data to calculate the new sigma level
Closure VS Complete & Recognition

Closure:
• No more work required by the GB or BB
• No more budget
• Changes in outside condition
• Waiting for capital (will be re-open when will be approved)
• Etc.

Note: a project may be closed in all phases

Complete:
• When proof of control is achieved

Communicate completion & Recognition:
• Sponsor is in charge to recognize team members efforts appropriately
• Forward the documentation to the Black Belt
• Look at leverage opportunities for the business
• Give a new project to the GB or BB
End of Control Phase - Board Presentation

Purpose: Get people focus

Agenda:
1 slide
• Small resume of the Define Phase (Pain, SIPOC, CTQ)
1 slide
• Control Plan

Appendix
• Documentation
  1-3 slides
  • Results
  • Control Charts
  • Statistical tools
  • New Measurement System Analysis
  • New Sigma Level

1 slide
• Ownership
• Control
• Control Charts
• Leverage Opportunities

1 slide
• Next Project

Maximum of 5 to 10 Minutes
Strictly enforced