The use of Six Sigma on the Pharmaceutical Industry

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Lean-Six Sigma Black Belt

Pfizer Puerto Rico
Pyramid of High Performance Business

Customer
VOC
(Defines Value)

Products
(Service / Goods)
(Business)

Suppliers – Inputs \( X \) – Process – Outputs \( Y \) – CTQ

Business needs to focus on CTQ

CTQ
(Defect Control & Reduction)

Six Sigma Tools

CTQ

DMAIC
DMAIC:
Universal Problem-Solving Methodology
5 Logically Linked Steps

Define
Measure
Analyze
Improve
Control
DMAIC Objective

Practical (Problem / Opportunity)

Statistical Problem (6-sigma tools)

Statistical Solution (6-sigma tools)

Practical Solution / Improvement
1. The Define Phase

- **Define**
  - Project Charter
  - SIPOC Analysis
  - Voice of the Customer

- **Measure**
  - Data Collection & Operational Def.
  - Data Measurement Tools: Funneling, Sampling, Minitab, Gage R&R, Patterns, Stratification, Process Capability

- **Analyze**
  - Data Analysis Tools: Cause & Effect Diagrams, Stratification, Hypothesis Testing, Regression Analysis, Design of Experiments

- **Improve**
  - Generating, Evaluating, & Selecting Solutions, FMEA, Pilots, Implementation Planning

- **Control**
  - Control Plan, Standardization, Monitoring, Key Learning's, Project Closure
2. Measure Phase

- Project Charter
- SIPOC Analysis
- Voice of the Customer

- **Data Collection & Operational Def.**
  - Data Measurement Tools: Funneling, Sampling, Minitab, Gage R&R, Patterns, Stratification, Process Capability

- Data Analysis Tools: Cause & Effect Diagrams, Stratification, Hypothesis Testing, Regression Analysis, Design of Experiments

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- Control Plan, Standardization, Monitoring, Key Learning's, Project Closure
**Data Collection Plan**

**What is the data trend?**

Does the data indicate any particular distribution?

Is there any outlier in the available data set?

<table>
<thead>
<tr>
<th>Data</th>
<th>Operational Definitions &amp; Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>What</td>
<td>Measure Type, Unit of Measure</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

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**INDUNIV research consortium**
Gage R&R Analysis

Components of Variation

- % Contribution
- % Study Var
- % Tolerance

R Chart by Gage Operator

- Sample Range: 0.10
- UCL=0.0343
- R=0.0133
- LCL=0

Xbar Chart by Gage Operator

- Sample Mean: 56.70, 56.65, 56.60
- UCL=56.6499
- X=56.6363
- LCL=56.6227

Gage Weight (KG) by GAGE Drum No.

Gage Weight (KG) by Gage Operator

Gage Operator * GAGE Drum No. Interaction
Stratified Time Series Plot

Time Series Plot of % Yield

Day
- Fri
- Mon
- Thu
- Tue
- Wed

Date Produced

% Yield

1/31/05  3/4/05  4/8/05  5/13/05  6/17/05  7/22/05  8/26/05  9/30/05  11/4/05  12/9/05  1/13/06
Process Capability Report

Using Box-Cox Transformation With Lambda = 0.45

I Chart

UCL=0.2677
X̄=0.1722
LCL=0.0766

Moving Range Chart

UCL=0.1174
MR=0.0359
LCL=0

Last 25 Observations

Values

Within

Specs

Overall

Within

Overall

Transformed Capa Plot

Within

Cp *

Cpk 0.47

StDev 0.0318476

Pp *

Ppk 0.44

Cpm *

Capsule Filling Date: July to December 2008

Capability Histogram

Specifications

LSL* 0.127211

Normal Prob Plot

AD: 0.411, P: 0.339

StDev 0.0340961

inds

control
3. **Analyze Phase**

- **Define**
  - Project Charter
  - SIPOC Analysis
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- **Measure**
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- **Control**
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Cause & Effect Diagram

Define → Measure → Analyze → Improve → Control

- Methods
  - Material
  - Machine
  - Manpower
  - Environment

Problem / Opportunity
Regression Analysis
Experimental Design Results
Surface plot of Response vs. Two Variables

Design-Expert® Software
Transformed Scale
\[ \sqrt{\text{Response}} \]

- 5.2915
- 0

X1 = B: LOD
X2 = D: Vacuum

Actual Factors
A: Thickness = 0.080
C: PH = 5.15

Response

D: Vacuum
B: LOD
Hypothesis testing to demonstrate significance of Change

Two-sample T for Transformed data

<table>
<thead>
<tr>
<th>Period</th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
<th>SE Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before June_09</td>
<td>22</td>
<td>0.536</td>
<td>0.830</td>
<td>0.18</td>
</tr>
<tr>
<td>Post June_09</td>
<td>12</td>
<td>-0.655</td>
<td>0.939</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Difference = μ (Before June_09) - μ (Post June_09)

Estimate for difference: 1.191

95% CI for difference: (0.516, 1.866)

T-Test of difference = 0 (vs not =): T-Value = 3.68  P-Value = 0.001  DF = 20
4. Improve Phase

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- Generating, Evaluating, & Selecting Solutions, FMEA, Pilots, Implementation Planning

- Control Plan, Standardization, Monitoring, Key Learning’s, Project Closure
# FMEA Assessment for Identified Solutions

<table>
<thead>
<tr>
<th>Key Process Step or Input</th>
<th>Potential Failure Mode</th>
<th>Potential Failure Effects</th>
<th>S E V</th>
<th>Potential Causes</th>
<th>O C C</th>
<th>Current Controls</th>
<th>D E T</th>
<th>R P N</th>
<th>Actions Recommended</th>
</tr>
</thead>
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- **What is the Process Step or Input?**
- **In what ways can the Process Step or Input fail?**
- **What is the impact on the Key Output Variables once it fails (customer or internal requirements)?**
- **How Severe is the effect to the customer?** 1=not severe, 10=extremely severe
- **What causes the Key Input to go wrong?**
- **How often does cause or FM occur?** 1=highly unlikely to ever occur, 10=we expect it to happen all the time
- **What are the existing controls and procedures that prevent either the Cause or the Failure Mode?**
- **How well can you detect the Cause or the Failure Mode?** 1=we have excellent controls, 10=we have no controls or extremely weak controls
- **Risk Priority Number (SEV x OCC x DET)**
- **What are the actions for reducing the occurrence of the cause, or improving detection?**
Pilots

- Find flaws in the solution
- Improve the solution before full-scale implementation
- Find out if you are getting the results you expected.
5. Control Phase

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Control Phase Results

Before Implementation: Non-stable process

After Implementation: Stable Process
Six Sigma Projects Related to:

• Complaint Investigations
• Deviation Investigations
• Environmental Projects
• Laboratory Data / Specifications / Stability
• Lead Time Optimization
• Process Optimization
• Product Optimization
• Safety Assessments & Investigations
Summary

• 6-Sigma tools are embraced by a 5 logically linked steps, DMAIC, which enables tools understanding and proper use

• Each year hundreds of projects are completed using 6-sigma tools

• These projects add significant benefits to the business performance; related to quality, safety, process performance and other
End