Introduction

- Understand variability, its impact and behavior.
- Learn how to effectively apply PVR tools to reduce variability in your work process.
- Understand your role in PVR.
- Be prepared to start PVR in your area.

What is PVR?

Process Variability Reduction or PVR is an approach to reduce variation in our transactional processes in a way that dramatically reduces the variation in our transactional outputs.

Processes: Customer Service, Job Instructions, Pre-Press, Invoicing, Shipping, etc.

PVR increases process stability, consistency, and quality
Understanding Variation

- All things vary - no two things are exactly the same.
- All variation has a source.
- The cause of poor performance is unmanaged sources of variation.
- We can manage variation by identifying and removing the source!

Understanding Process Variability and Reducing Defects and/or Cycle Time

Traditional View of Variation
Therefore….

Process Variation is the Enemy of Quality & Performance!

Using Six Sigma - The DMAIC Approach

- Define the problem or issue.
- Measure the outcome.
- Analyze what is driving or causing the problem.
- Improve the process by acting on the information and confirming the outcome.
- Control the new process to maintain the gain.

Shall see how to reduce process variation through Six Sigma

Define
Simple PVR Define Tools

- Customer Interview
- Process Maps
- Standard Operating Procedures/Work Instructions
- Value added Analysis
- Spaghetti Diagrams

Exercise: Paper Airplanes

- Form a team of 5 people
- Make 25 airplanes
- All team members must conduct at least one step in the construction process.
- The first team member to touch the plane (start the process) time stamps the plane.
- The last team member to touch the plane (stop the process) time stamps the plane.

Exercise: Paper Airplane SOP

1. Fold the paper in half.
2. Fold the left wing in to the center of the airplane.
3. Repeat step 2 with the right wing.
4. Fold both wings out.
5. Extend wings for flight.
Look Downstream, work Upstream

1. Start by understanding what the customer wants

2. Then define the process intended to provide this

3. The right efforts made here, by the right team will improve the process

4. So that results show here

Don’t be insane by....

Doing the same thing today that you did yesterday, and expecting a different outcome

Albert Einstein

Customer Interview

- Important information gathering technique to identify and understand customer needs.
- Able to ask follow-up questions to gather more complete and useful feedback.
- Fosters cooperative working relationships between customer and supplier.
- Must be well planned.

Remember, customers can be internal or external
Customer Interview Suggestions

- Ask:
  - “What barriers do you face in doing …?”
  - “What issues do you encounter when …?”
  - “What are the main issues as they relate to …?”
  - “In an ideal world, what would you improve?”
  - “Why is that true?”
  - “Tell me more about that.” “Give me an example.”
- Open-ended questions.

LISTEN!

Conduct the interview in a way that the person(s) being interviewed feel like the customer.

Airplane Customer

- What does the airplane customer want?
- What is their objective?
- Might knowing this give you any ideas on how you should build and fly your airplane?

Simple PVR Define Tools

- Customer Interview
- Process Maps
- Standard Operating Procedures/Work Instructions
- Value added Analysis
- Spaghetti Diagrams
Process Map or Flowchart

- Visual *description* of the process.
- Identifies customers and suppliers.
- Used to *identify process* measures and key measures (discussed later).
- Points out discrepancies in the process.
- Points out inefficiencies in the process.
- Initiates *standardization* of procedures.
- Serves as a training tool.

Who is the Customer?

**Customers Are Recipients of Products and/or Services**

- Customer
- Internal
- External

Internal Customers use our outputs for their processes.
External Customers pay our bills . . .

Who is the Supplier?

**Suppliers Provide Products and/or Services**

- Supplier
- Internal
- External

Outputs of Internal Suppliers are inputs to our process.
We pay External Suppliers.
Process Map Example: Shipping

Inputs:
- Origin
- Destination(s)
- Delivery Time
- Weight
- Lane Selection
- Carrier Selection

Carrier Assigned

Truck departs at origin

Truck reaches destination

Cost Incurred

Outputs:
- Cost
- CWT

Is this a: Want it to be, Believe it to be, or an Actually is map?

Using the Process Map

There are usually 3 versions of each Process Map

What you Want it to be, What you Believe it is, What it Actually is

SOPs

Simple PVR Define Tools

- Customer Interview
- Process Maps
- Standard Operating Procedures/Work Instructions
- Value added Analysis
- Spaghetti Diagrams
Standard Operating Procedure (SOP)/Work Instruction (WI)

- Written document that describes a process, and the procedure(s) we all agree to use to run the process.
- Includes critical people, policies, procedures, and plant.
- The “life blood” of TPVR.

Writing SOPs/WIs

- Process map the basic process.
- Process map main sub-processes.
- Write a detailed description of the work to be done, following the process map.
  - All obvious sources of variability identified on the fishbone diagram should be addressed.
- Insert all information into the SOP/WI template.

How did our airplane SOPs stack up?

1. Fold the paper in half.
2. Fold the left wing in to the center of the airplane.
3. Repeat step 2 with the right wing.
4. Fold both wings out.
5. Extend wings for flight.

Do we need to create a new SOP??
Simple PVR Define Tools

- Customer Interview
- Process Maps
- Standard Operating Procedures/Work Instructions
- Value added Analysis
- Spaghetti Diagrams

Value Added Analysis

There are usually 3 versions of each Process Map

- What you Want it to be
- What you Believe it is
- What it Actually is

We often find many steps that are not value-added.

- Value-Added:
  - Customer recognizes the value
  - Changes the product
  - Done right the first time
Value Added Example

Value-added Analysis of Air Travel from NYC to Chicago

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrive Airport 1 hr before departure</td>
<td>60 min</td>
</tr>
<tr>
<td>Taxi from gate to runway</td>
<td>10 min</td>
</tr>
<tr>
<td>Flight to from NY to Chicago</td>
<td>121 min</td>
</tr>
<tr>
<td>Taxi from runway to gate</td>
<td>10 min</td>
</tr>
<tr>
<td>Wait at baggage carousel</td>
<td>15 min</td>
</tr>
<tr>
<td>Elapsed Time</td>
<td>216 min</td>
</tr>
</tbody>
</table>

Value-Added = 56%

Non-Value-Added Activity Reduces Speed

Analysing a Process Map for Non-Value Added Activities

- Validate the Process Map with a "walk through"
- Identify value-added and necessary steps
- Identify streamlining activities to improve process flow
- Develop "to-be" Process Map
- Validate "to-be" Process Map
- Develop implementation plan
- Implement changes (careful here)

Approaches to identify “To Be”: Process Streamlining

<table>
<thead>
<tr>
<th>WHAT</th>
<th>ELIMINATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHERE</td>
<td>COMBINE</td>
</tr>
<tr>
<td>WHEN</td>
<td>REARRANGE</td>
</tr>
<tr>
<td>WHO</td>
<td>PLACES</td>
</tr>
<tr>
<td>HOW</td>
<td>SEQUENCES</td>
</tr>
<tr>
<td></td>
<td>PERSONS</td>
</tr>
<tr>
<td></td>
<td>SIMPLIFY</td>
</tr>
</tbody>
</table>
**Approaches to identify “To Be”: Cycle Time**

- Add cycle times to Process Map. Include:
  - **Run Time** – time to actually perform the step
  - **Wait Time** – time unit sits waiting for movement to next step
  - **Queue Time** – time unit sits waiting for processing
  - **Changeover Time** – time to change from one unit to next unit
- Look for opportunities to reduce cycle time by eliminating steps, changing the sequence of steps, eliminating/minimizing movement between steps, etc.

**Necessary Steps**

A step may be non-value-added but necessary if:

- It is required by law, regulation, or contract
- It is required for safety, health, environmental, or ethical considerations

**Simple PVR Define Tools**

- Customer Interview
- Process Maps
- Standard Operating Procedures/Work Instructions
- Value added Analysis
- Spaghetti Diagrams
**Approaches to identify “To Be”: Spaghetti Diagram**

Create a Spaghetti Diagram of the path taken by a unit and/or information as it travels through the process. Identify steps done more than once and long travel distances.

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**Summary of Define**

- Variation is everywhere.
- **Process Maps** help us visualize the process steps and identify opportunities for streamlining the process, and removing variation.
- Standard Operating Procedures (SOPs)/ Work Instructions (WIs) describe the critical elements of a process so we can reduce variation in procedures.
- Other tools will be learned in the Analyze section to help us further identify and remove sources of variation.

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**Measure I**

What To Measure
Types of Measures

- **Key Measures** - Metrics describing quality of the process output, as viewed by the customer.
  - Tell us where we are versus where we should be.
- **Process Measures** - Metrics describing the inputs, steps, and/or components of the process.
  - Help us determine how to get where we should be.

Types of Measures

- Throughput
- Customer
- Time of Day
- Employee
- Location
- Defects
- Size
- Cycle Time
- Schedule Attainment
- Waste or Spoilage
- Cost
- Number of employees
- Proportion defective
- Number of errors

Look at this list. Which are more likely to be Process Measures and which Key Measures?
Measure Tools

- **Average**
- **Median**
- **Range**
- **Variability Ratio**

Describing Variation

- **Average or Mean** - tells you where the process is located.
- **Median** - tells you where the process is located.
- **Range** - the distance between the highest and the lowest points. Indicates spread.
- **Variability Ratio** - The ratio between the 1st and 3rd quartiles of data. Indicates spread.

Average or Mean

\[
\text{Average} = \frac{\text{Sum of all the data points}}{\text{Number of data points}}
\]

\[
\bar{x} = \frac{82\% + 20\% + 16\% + 14\% + 12\%}{5} = 28.8\%
\]

- Indicates location of process.
- Reflects all the data values.
- Influenced by extreme values.
Measure Tools

- Average
- Median
- Range
- Variability Ratio

Median

- The center number after the data has been sorted in ascending order.
- The 50th percentile of the data (also Q2).
- Indicates the location of the data.
- Does not use all values in the calculation
- "Robust" to extreme values.
Range

The distance between maximum value and the minimum value
Uses only two data points.
Influenced greatly by extreme values

Range = 82% - 12% = 70%

Measure Tools

- Average
- Median
- Range
- Variability Ratio

Variability Ratio - Q1/Q3

- VR is a number between 0 and 1.
- Is the ratio Q1/Q3 (the 25th and 75th percentiles).
- Indicates the amount of variation or spread existing in the process.
- The lower the number, the more variation.
- The higher the number, the less variation.
- "Robust" to an extreme value.
Variability Ratio - Q1/Q3

VR = Q1 / Q3
= 7362 / 8611
= .85

Procedure for Determining VR

- Collect at least 30 points of data
- Sort from smallest to largest.
- Divide the total number of points (N) by four. This is the number of points in each quartile.
- Q1 is the largest number in the first quartile.
- Q3 is the largest number in the third quartile.
- Divide Q1 by Q3. This is the Variability Ratio, VR.

VR Calculation Exercise

<table>
<thead>
<tr>
<th>Date</th>
<th>Value</th>
<th>Date</th>
<th>Value</th>
<th>Date</th>
<th>Value</th>
<th>Date</th>
<th>Value</th>
</tr>
</thead>
<tbody>
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<td>1/12</td>
<td>6623</td>
<td>1/14</td>
<td>7111</td>
<td>1/20</td>
<td>7765</td>
</tr>
<tr>
<td>1/27</td>
<td>3692</td>
<td>2/3</td>
<td>4124</td>
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<td>5434</td>
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<td>5453</td>
<td>2/12</td>
<td>6792</td>
<td>2/2</td>
<td>7410</td>
<td>2/7</td>
<td>8245</td>
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<tr>
<td>1/11</td>
<td>5586</td>
<td>1/24</td>
<td>6836</td>
<td>1/28</td>
<td>7420</td>
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<td>2/17</td>
<td>7650</td>
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<td>7110</td>
<td>2/1</td>
<td>7721</td>
<td>1/5</td>
<td>9773</td>
</tr>
</tbody>
</table>
VR Calculation Exercise

Variability Ratio $= \frac{Q_1}{Q_3}$

Variability Ratio $= \frac{6432}{7721}$

Variability Ratio $.83$

Measure II

Getting & Assuming Good Measures

Transactional Processes often measure:

- Cycle Time
- Defects and/or defectives
**Cycle Time**

- The actual time needed to complete a step and move on to the next step in the process.

**Defectives & Defects**

- A **Defective** unit is that which fails to meet customer requirements or standards.
  - Late order, incorrect invoice, short-count, etc.

- A **defect** is any reason for such a failure
  - Not filed correctly, incorrect line item, transposed numbers, etc.

- A **defective** unit can have more than one **defect**

**Defects per Unit (DPU)**

- **Defects Per Unit (DPU)** – the average number of defects, of all types, over the total number of units produced.
  - Unit is the item being processed – order, invoice, form, plate, etc.
  - DPU = (total defects) / (total units processed)


DPU Example

During the month of July, 220 invoices were sampled before being sent to customers. Among the 220 invoices, a total of 344 line items were found incorrect (defects).

Unit = Invoice

DPU = 344 incorrect line items/220 invoices
   = 1.56

Measure II Tools

- Operational Definitions
- Sampling
- Measurement System Analysis

Operational Definition

- A precise description of what is to be measured.
  - What is to be measured.
  - When it is to be measured.
  - Materials, information, or equipment to be used to measure it.
  - How it is to be measured.
  - Who is to measure it.

- Used to remove ambiguity in measurement and improve data integrity – no matter who does the measuring, the results are the same.
Measure II Tools

- Operational Definitions
- Sampling
- Measurement System Analysis

Sampling

- It is not always possible or feasible to gather and analyze 100% of the data from a process.
- We can **draw conclusions** about the process through **sampling**.

What Is A Sample?

- Collecting only enough individual data points from a process to determine the sources of variation.
- A fast, low cost way to describe a process.
Sources of Measurement Error

- Data must be available and accurate
- Most measurement issues are controllable, and fall in one of the following categories:
  - Data Unavailable
  - Recording/Judgement Errors
  - Keying Errors
  - Legibility Errors
  - Undefined and/or Poorly Defined Codes
  - Poorly Designed Forms

Minimizing Measurement Error

- Code unclear, recording/judgement errors and undefined codes
  - Develop operational definitions
  - Talk to each other; use email across shifts
  - Ensure everyone is identifying the same problem

- Legibility and keying errors
  - Write neatly
  - Do not assume that the data entry clerk knows what you are trying to say
  - Training
  - Over-communicate
Exercise: Do you know what time it is?

At a glance, what can we say about this Invoice Cycle Time measuring system?

<table>
<thead>
<tr>
<th>Sample</th>
<th>Invoicing CSR</th>
<th>Average</th>
<th>Range</th>
<th>Measure</th>
<th>Range</th>
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<th>Invoicing CSR</th>
<th>Average</th>
<th>Range</th>
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<th>Range</th>
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<td>687</td>
<td>750</td>
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<td>716</td>
<td>786</td>
<td>50</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>

A Simple M$\$A Index:

1) Estimate the measurement system variation.
2) Estimate the total observed variation.
3) Calculate the percent of total variation due to the measurement system.

A Simple M$\$A Index

\[
\text{Percent Measure Variation} = \frac{\sigma_{MS}}{\sigma_{obs}}
\]

- Where -

\[
\sigma_{MS} = \frac{\text{Average of the Measure Ranges}}{1.13}
\]

- And -

\[
\sigma_{obs} = \frac{\text{Average of the Process Ranges}}{1.13}
\]
MSA Exercise: Estimate Measure Variation

1) From the previous data, what is the average of the Measure Ranges (Invoicing v. CSRs)?

\[ R_{MS} = \frac{1247}{20} = 62.4 \]

What is the measurement system standard deviation or \( \sigma \)?

\[ \sigma_{MS} = \frac{62}{1.13} = 55.2 \]

MSA Exercise: Estimate Total Observed Variation

2) From the previous data, what is the average of the Process Ranges (Sample to Sample)?

\[ \overline{R}_{obs} = \frac{2265}{19} = 119.2 \]

What is the observed standard deviation or \( \sigma \)?

\[ \sigma_{obs} = \frac{119}{1.13} = 105.5 \]

MSA Exercise: Compute the Index

3) Compute the percent of measurement variation to total observed variation?

\[
\text{Percent Measure Variation} = \frac{55.2^2}{105.5^2} \\
\text{Percent Measure Variation} = \frac{3047}{11130} \\
\text{Percent Measure Variation} = .274 \text{ or } 27.4\% 
\]
MSA Exercise: Compute the Index

So how good is this measurement system?

“So So”

Summary

- Measures provide a baseline of where we are and show where we are going.
  - **Key measures** describe the process output.
  - **Process measures** describe the process inputs and potential sources of variation.
- Measures describe the process location and spread.
  - Average and **Median** measure the location.
  - Range and **Variability Ratio** (VR) measure variation time.
- **Defects** and **Cycle Time** are the two most critical measures for PVR.
- **Sampling** can be used to represent the process.
- Measures can be improved with good **measure procedures**.

Exercise: Paper Airplane Performance

- Identify and eliminate variation in making and flying paper airplanes:
  - Standardize the paper and the design.
  - Create a detailed Process Map of airplane construction.
  - Streamline the process.
  - Complete detailed SOP/WI Template.
- Construct airplanes using new SOP/WI. Measure cycle time and defects for each airplane.
- Record the data: airplane number, cycle time, number and type of defects.
- Calculate the Median and VR.
Analyze
Simple PVR Tools

Simple PVR Analyze Tools
- Brainstorming
- Fishbone Diagram
- FMEA
- Pareto Chart
- Histogram
- Run Chart
- Check Sheet
- Scatter Diagram
- 5 Why’s

Brainstorming
- Display a clear question the group is considering.
- Ask the group to answer the question with silent writing.
- Collect the ideas from each group member, in turn, one at a time.
  - No criticism or discussion
  - Do not interrupt others
  - Any individual may pass on any turn
- Record the ideas as stated for all to see.
- When everyone passes on the same turn, discuss the ideas.
  - Clarify
  - Combine similar ideas
  - Identify common themes or categories
Simple PVR Analyze Tools

- Brainstorming
- Fishbone Diagram
- FMEA
- Pareto Chart
- Histogram
- Run Chart
- Check Sheet
- Scatter Diagram
- 5 Why’s

Fishbone Example: Order Entry

Airplane Exercise: Use the Tools

- Brainstorm and Fishbone
- FMEA and Pareto
- Histogram and Run Chart
- Check Sheet and Scatter Diagram
- 5 Whys
Simple TPVR Analyze Tools

- Brainstorming
- Fishbone Diagram
- FMEA
- Pareto Chart
- Histogram
- Run Chart
- Check Sheet
- Scatter Diagram
- 5 Why’s

Prioritize Problems (“FMEA-like”)

- Prioritization will:
  - Provide a “Pareto-like” list of the problems
  - Guide team activities
  - Guide the tracking of those activities
  - Give a starting point of questions to ask and answers to find first

- We can use the priority calculation we used in the FMEA lecture!

Prioritize Problems

<table>
<thead>
<tr>
<th>Problem</th>
<th>Severity</th>
<th>Frequency</th>
<th>Detection</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>problem 1</td>
<td>1</td>
<td>20</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>problem 2</td>
<td>5</td>
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<td>problem 3</td>
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<td>1</td>
<td>50</td>
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<tr>
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<td>1</td>
<td>50</td>
<td>1</td>
<td>50</td>
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<tr>
<td>problem 6</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>125</td>
</tr>
<tr>
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<td>80</td>
<td>5</td>
<td>2000</td>
</tr>
<tr>
<td>problem 8</td>
<td>1</td>
<td>20</td>
<td>10</td>
<td>200</td>
</tr>
<tr>
<td>problem 9</td>
<td>1</td>
<td>10</td>
<td>10</td>
<td>100</td>
</tr>
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<td>problem 10</td>
<td>10</td>
<td>15</td>
<td>5</td>
<td>750</td>
</tr>
<tr>
<td>problem 11</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>problem 12</td>
<td>5</td>
<td>20</td>
<td>1</td>
<td>100</td>
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</table>
Simple TPVR Analyze Tools

- Brainstorming
- Fishbone Diagram
- FMEA
- Pareto Chart
- Histogram
- Run Chart
- Check Sheet
- Scatter Diagram
- 5 Why’s

Pareto Chart

- Shows the relative magnitude of a problem.
- Helps focus on the causes that will have the greatest impact if solved.
- Can provide multiple perspectives of the magnitude of the problem.
- Multiple levels can help to identify root causes and solutions.

Pareto Chart: Plate Defects by Frequency

![Pareto Chart for Category]

<table>
<thead>
<tr>
<th>Defect</th>
<th>Count</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>478</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>116</td>
<td>1.2</td>
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<tr>
<td></td>
<td>152</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>123</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>727</td>
<td>7.9</td>
</tr>
<tr>
<td></td>
<td>630</td>
<td>6.7</td>
</tr>
<tr>
<td></td>
<td>940</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>972</td>
<td>10.3</td>
</tr>
<tr>
<td></td>
<td>1680</td>
<td>18.0</td>
</tr>
</tbody>
</table>
Common Pareto Metrics

- Frequency
- Cost
- Time
- Rate or Percentage
- Value (£)
- Impact
- etc.
### Pareto Chart Procedure
- Make a list of categories or problems to compare.
- Select a standard unit of measurement or metric.
- Gather the data on a Check Sheet or other form.
- Draw bars representing the magnitude of the unit of measurement for each category, and display in order of magnitude.
- Review and act on the information!

### Simple PVR Analyze Tools
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### Histogram
- **Graphical summary** of data that has been collected from a process over a period of time.

- A **frequency bar chart** where the bars show the number of times a value occurs in the data.
A Histogram can be used to:
- Get a **snapshot** of the overall process performance or average.
- Get an idea of the **variation** around the average.
- Measure the output against specifications or targets.
- Get some initial **clues** for improvement.

Histogram and Specifications

Histogram of Cycle Times
Simple PVR Analyze Tools
- Brainstorming
- Fishbone Diagram
- FMEA
- Pareto Chart
- Histogram

- Run Chart
- Check Sheet
- Scatter Diagram
- 5 Why’s

It would help a great deal to know WHEN these events occurred.

Histogram & Run Charts

Histograms and Run Charts
A Run Chart (Control Chart) shows how the process varies over time.

- Shifts, trends, intermittent problems and cyclic patterns can be detected.
- Vertical-axis is the unit of measure; horizontal-axis is time.

**Run Chart Patterns**

- Intermittent Variation
- Process Shift
- Cyclical Pattern
- Trend
- Rapid Swings of Variation

**Run Chart Example**

- Trends
- Special Causes
- Pattern?
Run Chart Procedure

- Gather data over time in sequence.
- Create a graph with a vertical line and a horizontal line.
  - The vertical line should cover the full range of measurements.
  - The horizontal line should cover the time period over which the data was collected.
- Plot the data on the graph, connecting the points.
- Interpret the chart. Look for trends, patterns and/or unusual data points.

Simple TPVR Analyze Tools

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Check Sheet

- Forms that allow systematic recording of information.
- Help answer the questions:
  - “How often are things happening?”
  - “When are things happening?”
  - “Where are things happening?”
- Once collected, the information can be analyzed using other PVR tools.
Check Sheet Example: Pre-Press

Check Sheets can be simple paper and pencil data collection:

<table>
<thead>
<tr>
<th>Problem</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Missing Font</td>
<td></td>
</tr>
<tr>
<td>Incorrect Font</td>
<td></td>
</tr>
<tr>
<td>Missing Page File</td>
<td></td>
</tr>
<tr>
<td>Page Style/Design Problem</td>
<td></td>
</tr>
<tr>
<td>Missing Graphic File</td>
<td></td>
</tr>
<tr>
<td>Graphic Format</td>
<td></td>
</tr>
<tr>
<td>Graphic Resolution</td>
<td></td>
</tr>
<tr>
<td>Color Separation</td>
<td></td>
</tr>
</tbody>
</table>

Check Sheet: Plate Scratches

X = 1 Scratch

Check Sheet Procedure

- Make a list of categories to measure or draw a map of the process components.
- Decide who will gather data and how.
- Design Check Sheet.
- Place an “X” or tick mark anywhere a problem is observed. The concentration or frequency of “Xs” indicates the problem areas.
- Review and act on the information!
**Simple PVR Analyze Tools**
- Brainstorming
- Fishbone Diagram
- FMEA
- Pareto Chart
- Histogram
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**Scatter Diagram**
- Good for finding and/or confirming *relationships between variables*.
- Can assist in identifying which process inputs impact the process output.
- Add evidence to opinion regarding cause and effect.
- Can identify clues for improvement.

![Scatter Diagram Image](image-url)
Scatter Diagrams Patterns

- **X and Y appear to be unrelated**
- **Y Increases as X Increases** (positive linear trend)
- **Y Decreases as X Increases** (negative linear trend)
- **Y is more variable as X increases**

X (Independent Variable)  Y (Dependent Variable)

Scatter Diagram Procedure

- Collect data on process measure and key measure from the same samples (e.g., from the same units of output, > 30).
- Draw a picture with an horizontal axis and a vertical axis, both scaled between their lowest and highest expected values.
- For each sample taken, plot the value of the key measure against the value of the process measure, placing a dot where the two meet.

Scatter Diagram: Cycle Time vs Number of Forms

- Scatter diagram showing a positive linear trend with cycle time increasing as the number of forms increases.

Cycle Time

Number of Forms

0 1 2 3 4

0 1 2 3

0 10 20 30
**Simple PVR Analyze Tools**

- Brainstorming
- Fishbone Diagram
- FMEA
- Pareto Chart
- Histogram
- Run Chart
- Check Sheet
- Scatter Diagram
- 5 Why's

**5 Whys**

- Technique to get from symptom to root cause.
- Asking “Why” as many as five times to get to root cause.
- By identifying root cause we can take action to prevent recurrence.

**5 Whys: Computer Failures**

```
Computer Failure
  |  Installed Incorrectly
  |  Recommended Incorrectly
  |  Software
      |  Not Written
      |  Written with Bug
      |  Not Written Clearly
      |  Not Written
      |  Not Packaged
      |  Typing Error

WHY?
```
Improve
Implementing Improvement & Reporting Progress

Implementation - Process
1) Root Cause Identification and Verification
2) Implementation Plans And Resources
3) Implement and Verify Results - Pilot Basis
4) Institutionalize and Maintain Results

1 - Root Cause Identification and Verification
- Identify Possible Causes
- Categorize Causes with a Fishbone Diagram
- Prioritize Investigation
- Verify with Data
- Determine corrective action
Implementation - Process

1) Root Cause Identification and Verification
2) Implementation Plans And Resources
3) Implement and Verify Results - Pilot Basis
4) Institutionalize and Maintain Results

2 - Implementation Plan

- Includes timing, responsibility, involvement of key stakeholders, and key milestones.
- Large tasks are divided into subtasks and outcomes defined for each subtask.
- Includes regular status reviews of the plan.
- Entire implementation team involved in creating the plan.
- Tools include: Action Item Register, Gantt Chart, Potential Problem Analysis.

Implementation - Process

1) Root Cause Identification and Verification
2) Implementation Plans And Resources
3) Implement and Verify Results - Pilot Basis
4) Institutionalize and Maintain Results
3 - Pilot
- Used to determine if proposed solution/process change will have the desired result, to uncover unanticipated consequences of proposed solution, to train people on the new process, and to build credibility for the new process.

- Examples:
  - Use new procedure for 1 week and capture what works/does not work. Refine procedure before final implementation.
  - Make several test runs of a new software using different types of transactions. Identify problems.

3 - Pilot: Implementation Verification
- Verify that the solution is practical
- Verify the expected results with data tools
- Check for unanticipated consequences

Implementation - Process
1) Root Cause Identification and Verification
2) Implementation Plans And Resources
3) Implement and Verify Results - Pilot Basis
4) Institutionalize and Maintain Results
4 - Institute and Maintain

- Formalize procedures
- Update work instructions and/or ISO documentation
- Train
- Communicate Results - Website
- Translate change with an Implementation Plan
- Audit results - ongoing basis

Control

Maintain the Gain

Process Control Tools

- Maintain a Visual Control Tool
- Audit of process to SOPs / WIs
- Mistake Proofing
Maintain Visual Control Tool

- A visual record of process performance should be clearly visible and maintained throughout and after the project success.
- The poorer the performance (more opportunity for improvement) the more frequently the record should be updated.
  - Use TPVR Weekly Report during at least the 16 weeks.
  - Perhaps switching to the less frequent Customer Scorecard once goal has been achieved.

Process Control Tools

- Maintain a Visual Control Tool
- Audit of process to SOPs / WIs
- Mistake Proofing

What is an Audit?

- Tool for maintaining gain.
- An audit is a process of checking for compliance and alignment.
- It provides a reality check for the division, the CI Manager and the area.
- It answers: “how are we doing?”
- It verifies points for celebration and points for correction.
- It provides the follow-through and commitment needed to advance.
Process Control Tools

- Maintain a Visual Control Tool
- Audit of process to SOPs / WIs
- Mistake Proofing

Mistake Proofing

Techniques that make it impossible to make mistakes. Include permanent changes to facilities, simplification of operations, and/or standard procedures.

Examples of Mistake-Proofing

- Home
  - Automatic Shut-Offs Irons
  - Ground Fault Circuit Breakers
  - Child-Proof Caps on Medications
- Retail
  - Tamper-Proof Packaging
  - Bar Coding at Checkout
- Office
  - Spell Check Software
  - Color-Coded Forms
  - Organized File System
- Automobile
  - Seat Belts
  - Automatic Head Lights

Questions for Designing Mistake-Proofing

- Purpose of the Mistake Proofing – to prevent or to detect?
- Outcome – what is the result when a mistake is detected or about to happen?
  - Control – self-corrects the process
  - Shutdown – shuts down the process
  - Warning – signals operator
  - Sensory Alert – operator senses
- Method – what method will be used to detect or prevent a defect?
  - Contact – physical contact between two or more things
  - Performance step – monitor steps being performed
  - Fix value – count items, steps, etc.
  - Easy to do it right – color coding, shapes, sizes, checklists, procedures, forms, simplified workflows, etc.
Control II

PVR Reporting Procedures

Standard PVR Reports

- PVR Weekly Report
  - Metric Report
  - Action Item Register
- Customer Scorecard

Weekly PVR Report

Purpose
- Primary reporting tool for the business and company senior management.
- Includes Histogram of key measure(s), Multi-level Pareto Chart of cause categories, Run Chart of key measure(s), and Action Item Register (AIR).
- Pareto chart and FMEA-like problem analysis should drive prioritized problem statements on Action Item Register.
- Must be completed weekly.
Weekly PVR Report: Metrics

Weekly PVR REPORT Template

<table>
<thead>
<tr>
<th>Category</th>
<th>Expected</th>
<th>Current</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pareto Chart Cycle Time

These are the things you should be working on.

Weekly PVR Report: Multi-level Pareto

Pareto Chart Cycle Time

Standard PVR Reports

- PVR Weekly Report
  - Metric Report
  - Action Item Register
- Customer Scorecard
**Action Item Register (AIR)**

- An action plan.
- Identifies the action(s) to be taken, who is responsible for the action, and the date the action is due.
- Actions are identified through data collection and analysis using the PVR tools.
- Should be used daily to plan area activities.
- Prioritizes actions and tracks progress.
- Ties problems to data to root cause(s) to action.

**Action Item Register**

**Purpose**

- An aid to help us link

<table>
<thead>
<tr>
<th>Problem</th>
<th>Analysis of Problem</th>
<th>Root Cause of Problem</th>
<th>Corrective Action</th>
<th>Evidence of Improvement</th>
<th>Control</th>
</tr>
</thead>
</table>

- Helps us prioritize and track the problems and issues.
- Ties to pareto charts (especially 2nd level) on PVR reports.
- Basis for customer scorecard, action plans and forecasted improvements.
- Help define the resource requirements.
- Identifies responsible person.

**Instructions for Weekly Report**

- One page for Cycle Time
- One page for Defects
- Updated Action Item Register
- Electronically mailed to your leadership weekly.
Standard PVR Reports

- PVR Weekly Report
  - Metric Report
  - Action Item Register
- Customer Scorecard

Customer Scorecard

**Purpose**

- To define the critical to quality (CTQ’s) needs of our “Customers”
- To define an improvement
- To define action plans with responsibilities, timing to support plan
- To track performance vs. plan
- To communicate our progress to our customer