Lean Six Sigma Analyze Phase

Analyze Phase Key Activities

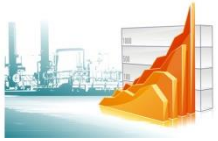
- Identify and analyze possible causes (X's) for the undesirable output
- Identify and understand which of the possible causes (X's) are the biggest contributors to the undesirable output
- Identify which causes (X's) are within the team's control and those outside their control
- Identify methods to verify the suspected big causes (X's)

Analyze Phase Key Activities (cont'd)

- Identify what data should be collected to validate the suspected big causes (X's)
- Identify and perform appropriate statistical tests to confirm suspected big causes (X's)
- Determine team commitment to improvement targets for the big causes (X's)
- Review and amend Cost of Poor Quality (COPQ) estimates
- Develop class project Analyze phase presentation

Analyze Phase Tools Covered in This Module

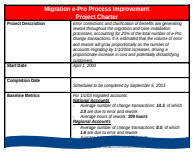
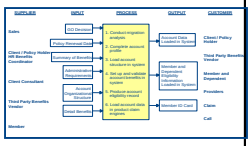
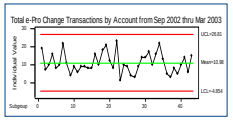
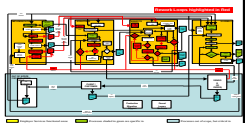
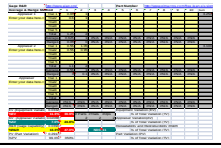
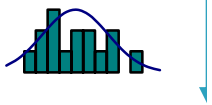
- Ishikawa (Fishbone Diagrams)
- 5 Why's
- Failure Mode and Effects Analysis (FMEA)
- Charts / Plots (Box & Whisker)
- Correlation and Regression Analysis (SLR)
- Hypothesis Testing

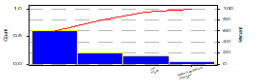
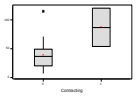
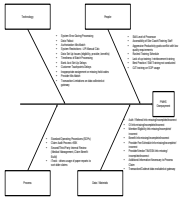


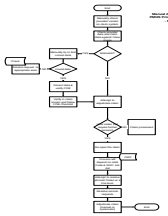
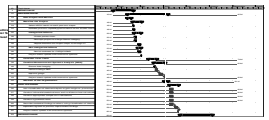
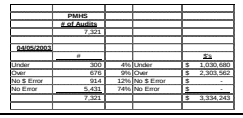
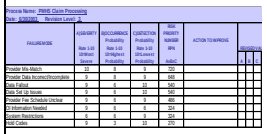
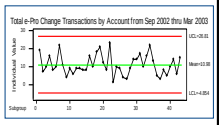
Some Other Tools That Can Be Used in the Analyze Phase

- Process Flow Analysis
- Brainstorming
- Pareto Charts
- Check Sheets
- Capability Analysis
- Control Charts
- Design of Experiments
- Gap Analysis
- Waste Analysis
- Cost of Poor Quality

Six Sigma Process Improvement Road Map

	Phase Objectives	Key Activities	Possible Tools and Techniques	Key Deliverables
1.0 Define Opportunity	Document the problem statement and establish the charter. Demonstrate alignment with the Business metrics and strategies. Determine Customer requirements and performance standards.	▪ Select Team with Champion ▪ Develop problem statement ▪ Develop Charter ▪ Create SIPOC ▪ Address gap between VOC and process ▪ Estimate financial benefits	 	▪ Problem Statements ▪ Project Charter ▪ SIPOC map ▪ COPQ or CODND ▪ Communication Plan
2.0 Measure performance	Develop a reliable and valid measurement system of the business process to effectively evaluate the success of meeting customer requirements.	▪ Obtain Customer requirements ▪ Create overall project plan ▪ Develop measurement plan & compile project metrics ▪ Determine defect tracking requirements ▪ Assess baseline performance-estimate process capability ▪ Measurement Systems Analysis	   	▪ Process Description ▪ Project Plan & Timeline ▪ Metrics and collection plan ▪ Baseline Performance results ▪ Process capability analysis ▪ Lean Tools Assessment ▪ Measurement Systems Analysis ▪ Process model – 'as is'

3.0 Analyze Opportunity	Utilization of data techniques to gain insight into process. Divide data into groups based on key characteristics and assess the root causes of errors and poor performance. Determine where to focus efforts for improvement.	▪ Statistical tests / tools
		  ▪ FMEA
		  ▪ Pareto chart
		  ▪ Correlation/Regression
		  ▪ Fishbone Diagram
		  ▪ Box plot
		  ▪ Hypothesis Testing
		▪ Describe findings – identify potential root causes RCA
		▪ Validate findings
			   	▪ Data relationships
				▪ Validated Key Input Variables (KPIVs) & Key Output Variables (KPOVs)
				▪ Prioritize sources of variation
				  ▪ root causes
				▪ Identify & communicate potential improvements
				▪ Summarize benefits & annualized financial benefits

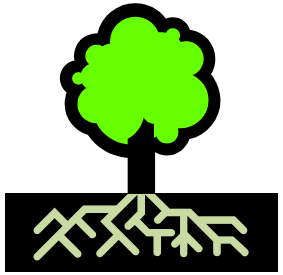
4.0 Improve Performance	Identify key change opportunities and proactively test for optimization. Develop implementation and communication plan including a change management approach to assist the organization in adaptation of the improvements.	▪ Design of Experiments – describe purpose & build test/ analysis strategy ▪ Evaluate and Confirm results ▪ Analyze KPIVs ▪ Create action plan for implementation including change management and communication needs ▪ Buy-in assessment	  	▪ Quantified relationship between key input and key output variables ▪ Defined process improvements including impacts and benefits ▪ Implementation Plan ▪ Process model – 'Should be' ▪ Impacted Employees are Trained
5.0 Control Performance	Definition of optimal process settings and conditions with specified metrics. Implementation of improvements with a control plan to assess & maintain gains.	▪ Implement improvements ▪ Evaluate results ▪ Integrate & manage improvements in work processes ▪ Complete closure activities	 	▪ Document process change ▪ Control plan ▪ Determine new process capability ▪ Leverage opportunities for replication ▪ Communicate results ▪ Financial audit ▪ Hand-off to process owner

Identify the Key Factors Which Cause Variation

Determining Root Cause

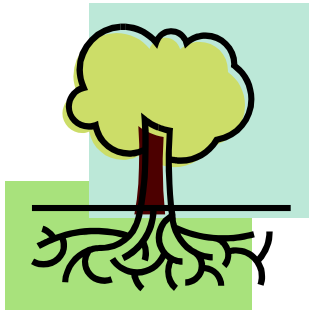
- There are two different sets of tools for determining the Root Cause of issues in the process
  - Subjective
  - Analytic

- We will cover the most commonly used tools in this module



Root Cause Analysis (RCA)

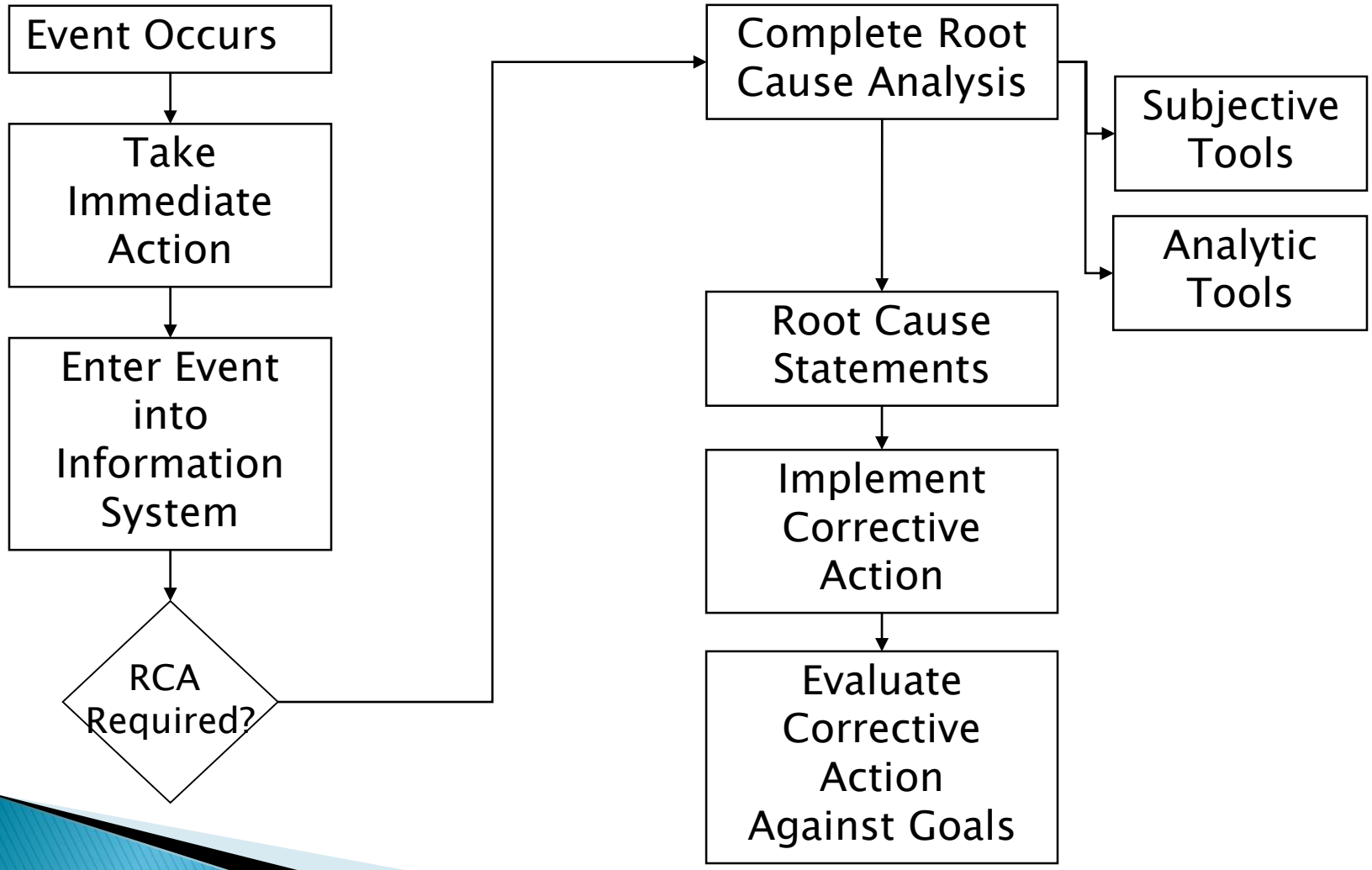
- What is a ‘Root Cause Analysis’?
  - Reactive assessment of basic or contributing causal factors associated with a specific event
    - In English – what was the real “cause” of the issue!
  - Analysis focused primarily on system and process issues rather than assigning individual responsibility



Root Cause Analysis (RCA)

- A method used to help drill down into the process steps to determine the basic causal factors associated with each failure mode
- Allows the group to obtain root cause information about an event
- Uncovering root causes is critical to process improvement.
- If left uncovered the team is simply “band-aiding” a problem temporarily

Root Cause Analysis (RCA)



Subjective and Analytic Tools

- Subjective (Soft) Tools
  - Flow Analysis (M)
  - Ishikawa (Fishbone)
  - 5 Whys
  - FMEA
  - Graphical Analysis
  - Brainstorming Process (I)
- Analytic Tools
  - Pareto (M)
  - Checksheets (M)
  - Capability Analysis (M)
  - Control Charts (M)
  - Regression Analysis
  - Analytical Tests (Hypothesis Testing)
  - Design of Experiments – DOE (I)

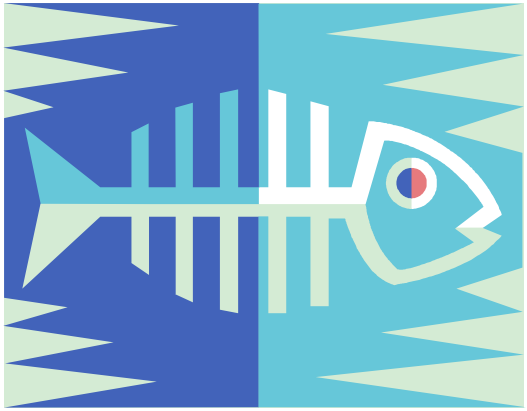
Often used 1st on the process

Often used to verify subjective tests

(M) = covered in the Measure Phase; (I) = covered in the Improve Phase

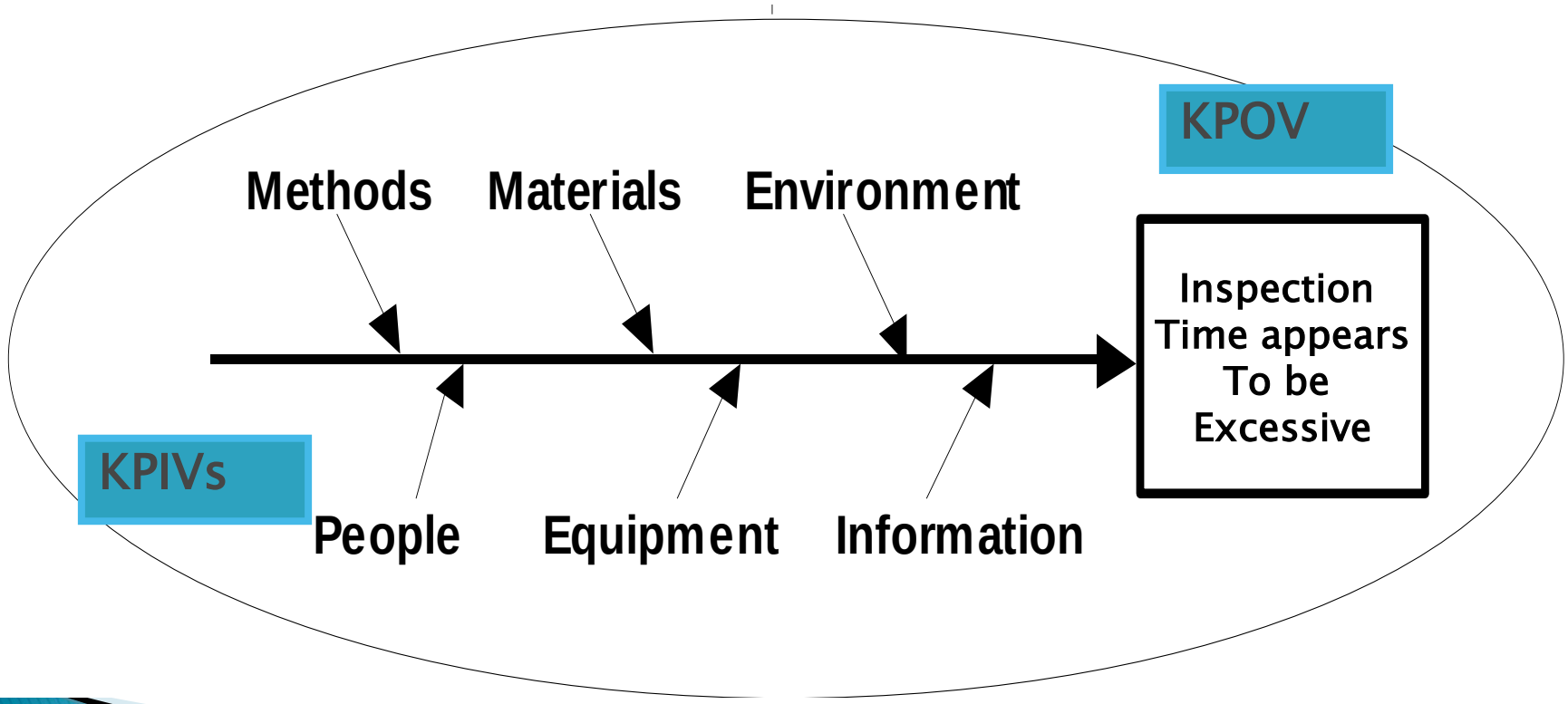
Cause & Effect Diagram

- Also known as Ishikawa fishbone diagram
- Visual representation of known causes to a particular effect
- Allows the team to drill down in a systematic way to identify major contributing KPIV's



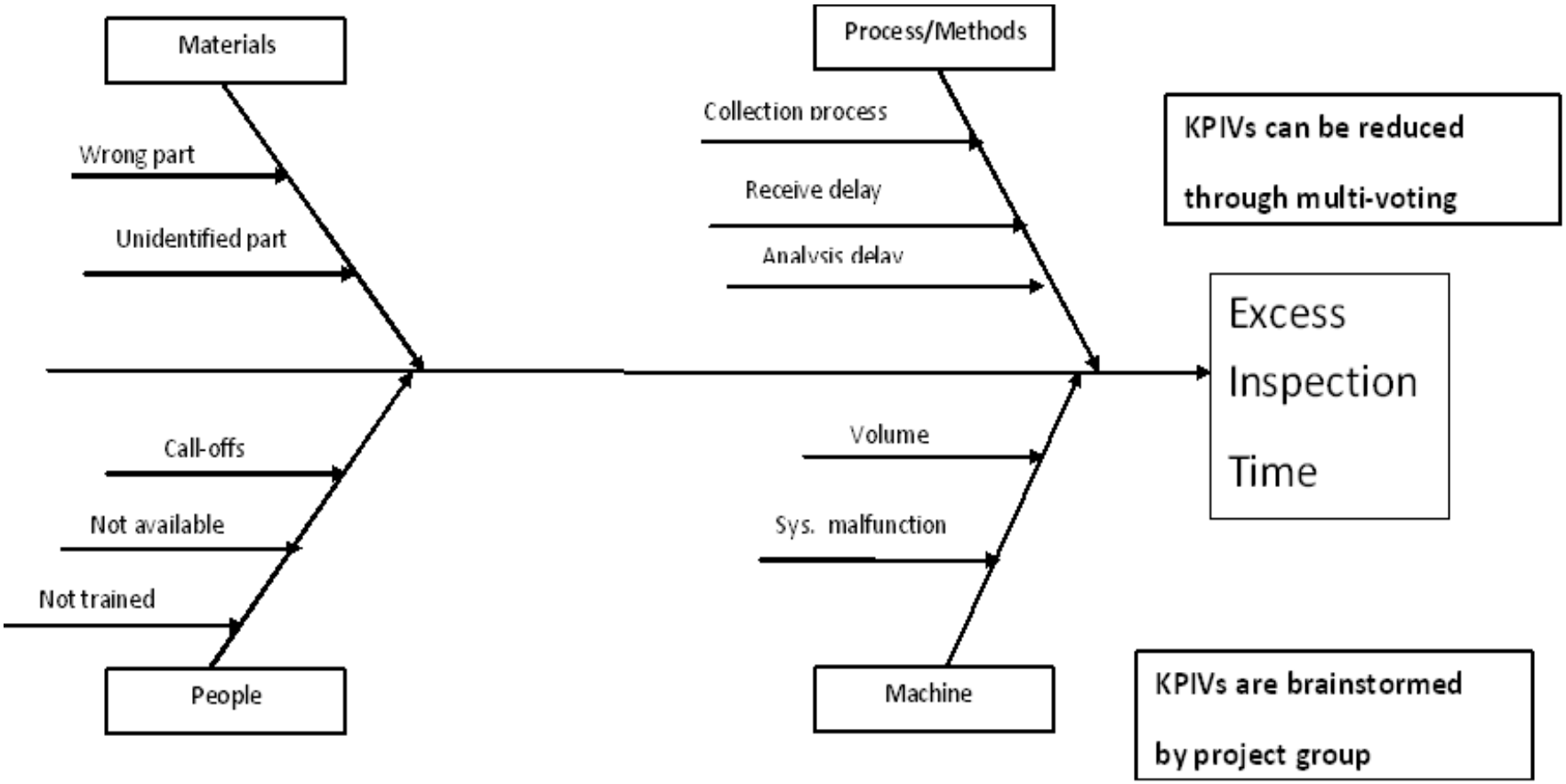
Ishikawa Diagram:

- An Ishikawa Diagram (a.k.a fishbone diagram) can be used to map the process input



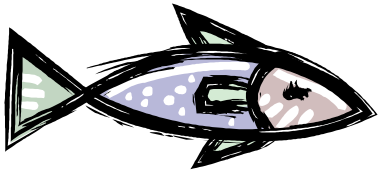
Ishikawa Diagram

Analyze 3 – ISHIKAWA diagram template



Exercise – Fishbone

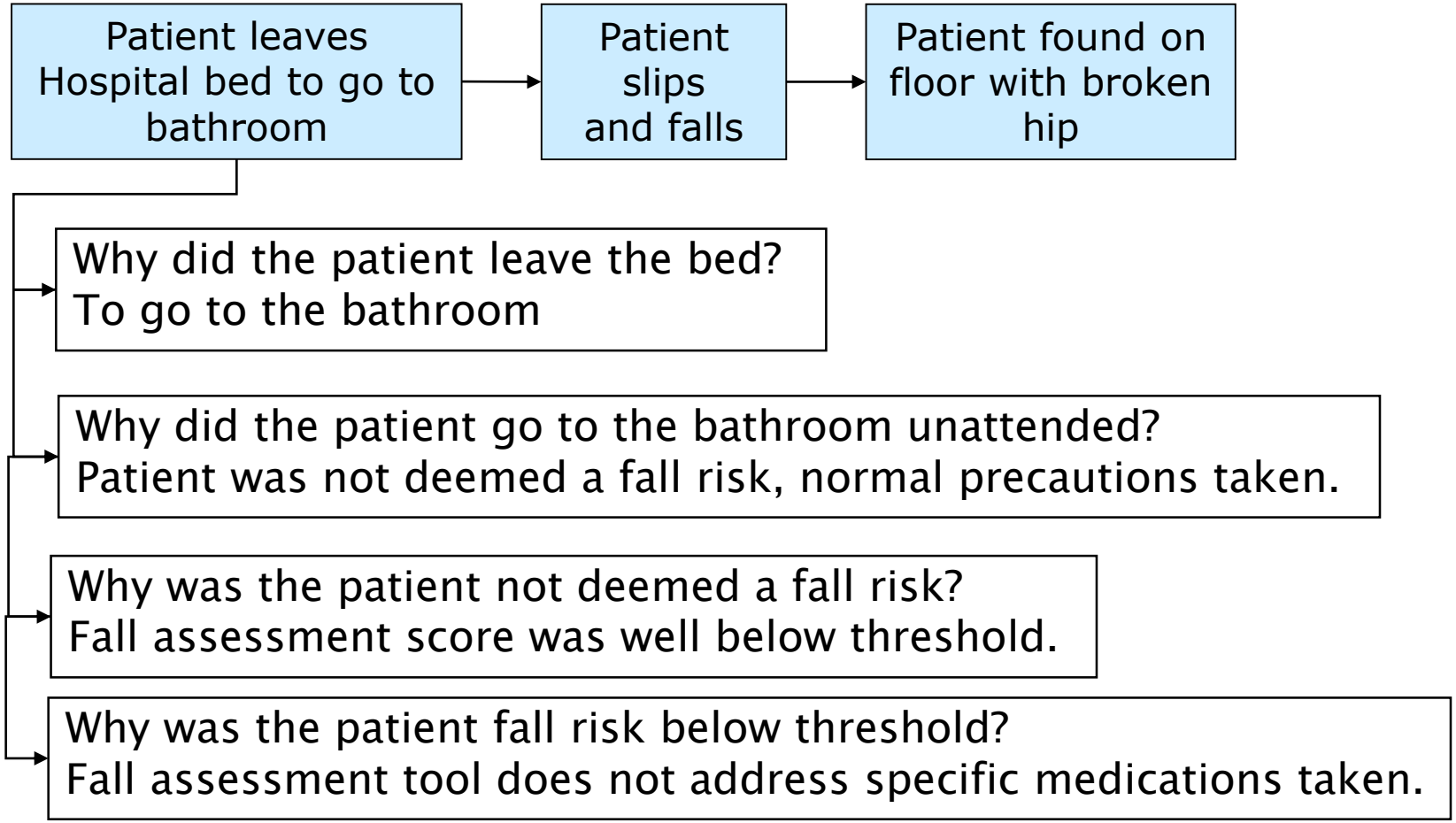
- As a class, construct a Fishbone Diagram for the Class Scenario
  - You can use sticky notes or use a spreadsheet to list the factors in the columns
  - Start by determining the outcome
  - Fill in the “bones”
    - Write down all the factors
    - Don’t debate their relative merits; the purpose is to understand the possible inputs
- The class has 5-10 minutes for this exercise



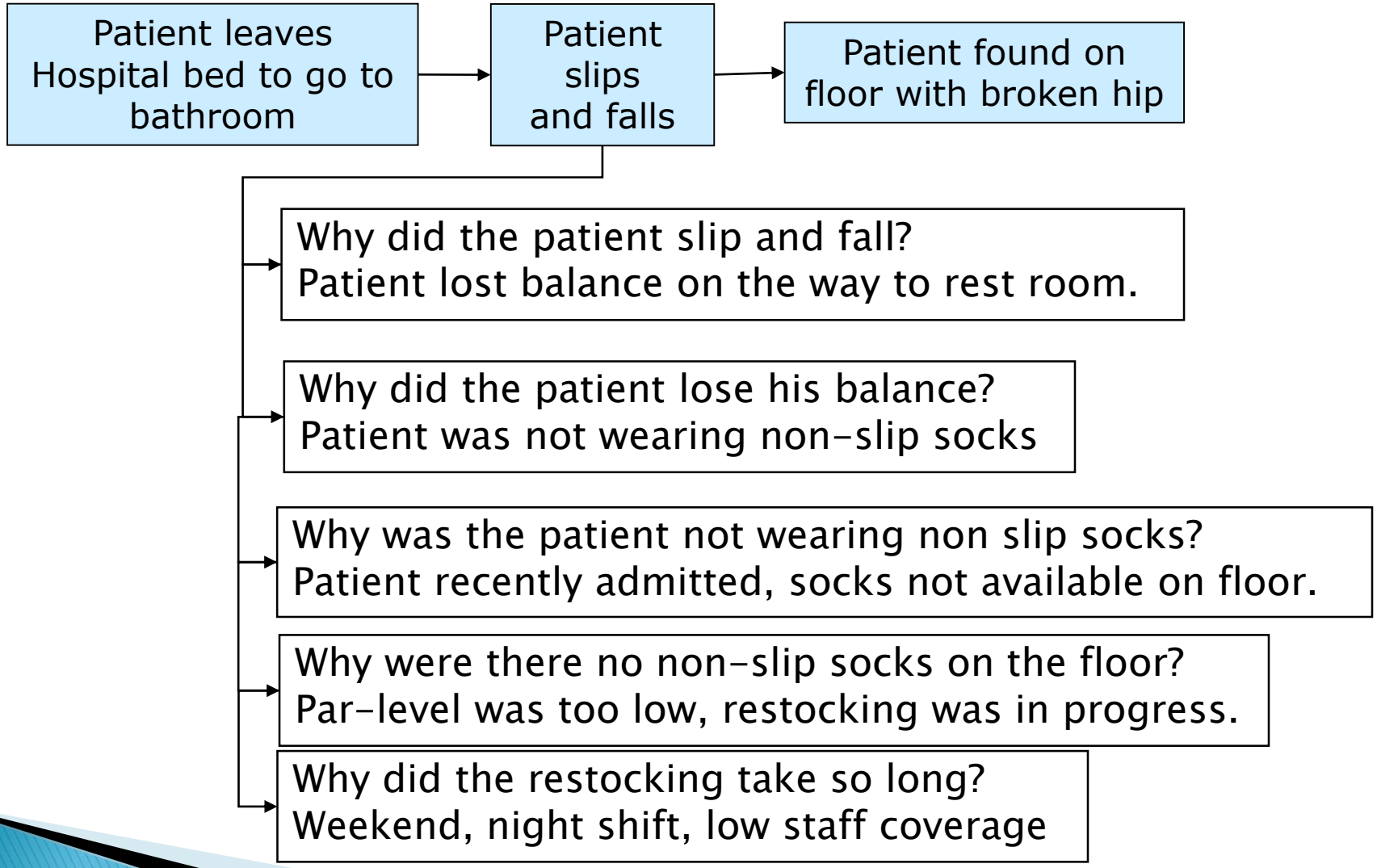
The 5 Why's

- For each step in the process ask:
  - What problems occurred during this step?
  - Why did these problems occur?
- If the answer from the first question does not provide the root cause, keep asking "why?" until the root cause is reached.

5 Why's Example



Another 5 Why's Example



Exercise – 5 Whys

- When I fill my gas tank it overflows. Can I determine the root cause?

- At work we run out of material. Can I determine the root cause?

FMEA (Failure Modes and Effects Analysis)

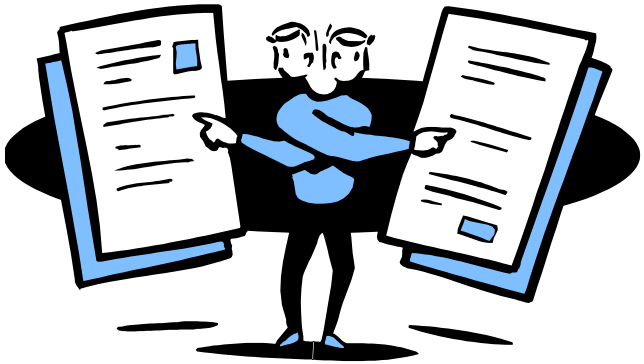
- Used to identify all possible failure modes and their effects on a system
- Used to identify critical parameters
- An excellent tool for supporting a company's commitment to continually improve products and services wherever possible
- Can focus on a process or the design of a new product

FMEA

- Think of this as a priority list;

  NOT of the things that can go wrong… BUT the things that have to go right.

- 2 Types of FMEA
  - DFMEA – Design FMEA
  - PFMEA – Process FMEA



Benefits of FMEA Analysis

- Improved product functionality & robustness
- Reduced Warranty costs
- Reduced day-to-day operations issues
- Improved safety of products & implementation process
- Reduced business process problems

Implementing Issues

- Know it is a living document and needs to be reviewed periodically
- Conduct early in an improvement to:
  - Design out failure modes by identifying/removing root causes
  - Reduce seriousness of failure if elimination is not possible
  - Reduce the occurrence of failures
  - Improve detection of failures

Road Map to FMEA

- Note an input to a design or process (e.g. process step, KPIV, Cause & effect matrix)
- List 2 or 3 ways the input/function can go wrong (a failure)
- List at least one effect for each potential failure mode
- For each failure mode, list 1 or more causes of input going wrong
- For each cause list at least 1 method of preventing or detecting the failure
- Enter SOD values

- You can use the template DOE Gage R&R FMEA > Failure Mode Effects Analysis
  - Tab PFMEA (A)

FMEA Layout

Process Operation	Process Failure	Effect	SEV	Cause	OCC	Controls	DET	RPN	Actions Taken

- **Process Operation:**
  - Process step under investigation
- **Process Failure:**
  - Way the process could fail to meet the customers requirements. Every process parameter failure should be taken into account even it is controlled

FMEA Layout

Process Operation	Process Failure	Effect	SEV	Cause	OCC	Controls	DET	RPN	Actions Taken

- **Effect:**
  - Effect of the process failure on the *product, process parameter, or customer*
- **Severity (SEV)**
  - Rank on a scale of 1 to 10. The highest #10 associated with a safety concern and the lowest #1 associated with a non-concern.

Severity Rating Scale

(Should be tailored to meet the needs of your company)

Rating	Description	Definition (Severity of Effect)
10	Dangerously high	Failure could injure the customer or an employee.
9	Extremely high	Failure would create noncompliance with federal regulations.
8	Very high	Failure renders the unit inoperable or unfit for use.
7	High	Failure causes a high degree of customer dissatisfaction.
6	Moderate	Failure results in a subsystem or partial malfunction of the product.
5	Low	Failure creates enough of a performance loss to cause the customer to complain.
4	Very Low	Failure can be overcome with modifications to the customer's process or product, but there is minor performance loss.
3	Minor	Failure would create a minor nuisance to the customer, but the customer can overcome it without performance loss.
2	Very Minor	Failure may not be readily apparent to the customer, but would have minor effects on the customer's process or product.
1	None	Failure would not be noticeable to the customer and would not affect the customer's process or product.

Notes on Severity

Caution! Severity ranking should NOT be considered low just because its *occurrence* is low, or because its *detection* is very effective.

Note: A reduction in SEVERITY rank is normally achieved through a design change to the system/sub-system that uses the device.

FMEA Layout

Process Operation	Process Failure	Effect	SEV	Cause	OCC	Controls	DET	RPN	Actions Taken

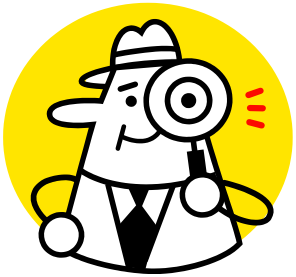
- **Cause:**
  - How could the failure occur? Is there something that could be controlled?
- **Occurrence (OCC):**
  - Rank on a scale of 1 to 10, on the basis of the likelihood that the process failure will occur. Rank of 10 meaning the failure is sure to occur and 1 meaning the failure is unlikely to occur.

Occurrence Rating Scale

(Should be tailored to meet the needs of your company)

Rating	Description	Potential Failure Rate
10	**Very High:** Failure is almost inevitable.	More than one occurrence per day or a probability of more than three occurrences in 10 events (Cpk < 0.33).
9	**High:** Failures occur almost as often as not.	One occurrence every three to four days or a probability of three occurrences in 10 events (Cpk ≈ 0.33).
8	**High**: Repeated failures.	One occurrence per week or a probability of 5 occurrences in 100 events (Cpk ≈ 0.67).
7	**High**: Failures occur often.	One occurrence every month or one occurrence in 100 events (Cpk ≈ 0.83).
6	**Moderately High:** Frequent failures.	One occurrence every three months or three occurrences in 1,000 events (Cpk ≈ 1.00).
5	**Moderate:** Occasional failures.	One occurrence every six months to one year or five occurrences in 10,000 events (Cpk ≈ 1.17).
4	**Moderately Low**: Infrequent failures.	One occurrence per year or six occurrences in 100,000 events (Cpk ≈ 1.33).
3	**Low:** Relatively few failures.	One occurrence every one to three years or six occurrences in ten million events (Cpk ≈ 1.67).
2	**Low:** Failures are few and far between.	One occurrence every three to five years or 2 occurrences in one billion events (Cpk ≈ 2.00).
1	**Remote:** Failure is unlikely.	One occurrence in greater than five years or less than two occurrences in one billion events (Cpk > 2.00).

FMEA Layout



Process Operation	Process Failure	Effect	SEV	Cause	OCC	Controls	DET	RPN	Actions Taken

- **Controls:**
  - What are the controls that are currently in existence to *prevent* process failure from occurring OR to *detect* the effect of failures.
- **Detectability (DET):**
  - Rank on a scale of 1 to 10, based on the probability that the process controls will detect the process failure (prevention) or the effect of the process failure (detection).
  - Rank of 10 indicates that there is absolute certainty of non-detection and 1 means the control is certain to detect the failure.

Detection Rating Scale

(Should be tailored to meet the needs of your company)

Rating	Description	Definition
10	Absolute Uncertain	No inspection or the defect caused by failure is not detectable.
9	Very Remote	Product is sampled, inspected, and released based on Acceptable Quality Level (AQL) sampling plans.
8	Remote	Product is accepted based on 'no defectives' in a sample.
7	Very Low	Product is 100% manually inspected.
6	Low	Product is 100% manually inspected using go/no-go or other mistake-proofing gauges.
5	Moderate	Some Statistical Process Control (SPC) is used in process and product is final inspected off-line.
4	Moderately High	SPC is used and there is immediate reaction to out-of-control conditions.
3	High	An effective SPC program is in place with process capabilities (Cpk) greater than 1.33.
2	Very High	All product is 100% automatically inspected.
1	Almost Certain	The defect is obvious or there is 100% automatic inspection with regular calibration and preventive maintenance of the inspection equipment.

FMEA Layout

- **Risk Priority Number (RPN):**
  - Quantifies the risk associated with a given process failure mode.

RPN = Severity (S) x Occurrence (O) x Detection (D)

RPN ranks between 1 and 1000

Caution! Even if the RPN is low, a severity rating of 10 needs to be addressed.

- **Action:**
  - Activity that needs to be initiated due to high risks identified by the RPN rating. Although there is no rule for a threshold, typically above 125 is considered an actionable level.

Graphical & Statistical Analysis

The Goal of Analyze – Discovering the Interaction between KPIVs & KPOVs

- Investigate the process and data to determine the biggest contributors to the undesirable output (Y = f(X))
- Find patterns and data to support observations
- Separate the vital few from the trivial many KPIV's
- Prove the major contributors with data

Data Analysis Tools

The Analysis of Data

- Graphical Analysis reveals apparent signs of process differences leading to potential solutions
  - Example: The Box Plot will show the differences in variation for multiple groups for data
- Statistical Analysis proves statistical differences which can be exploited for finding solutions; graphical analysis is used as a prelude to statistical analysis

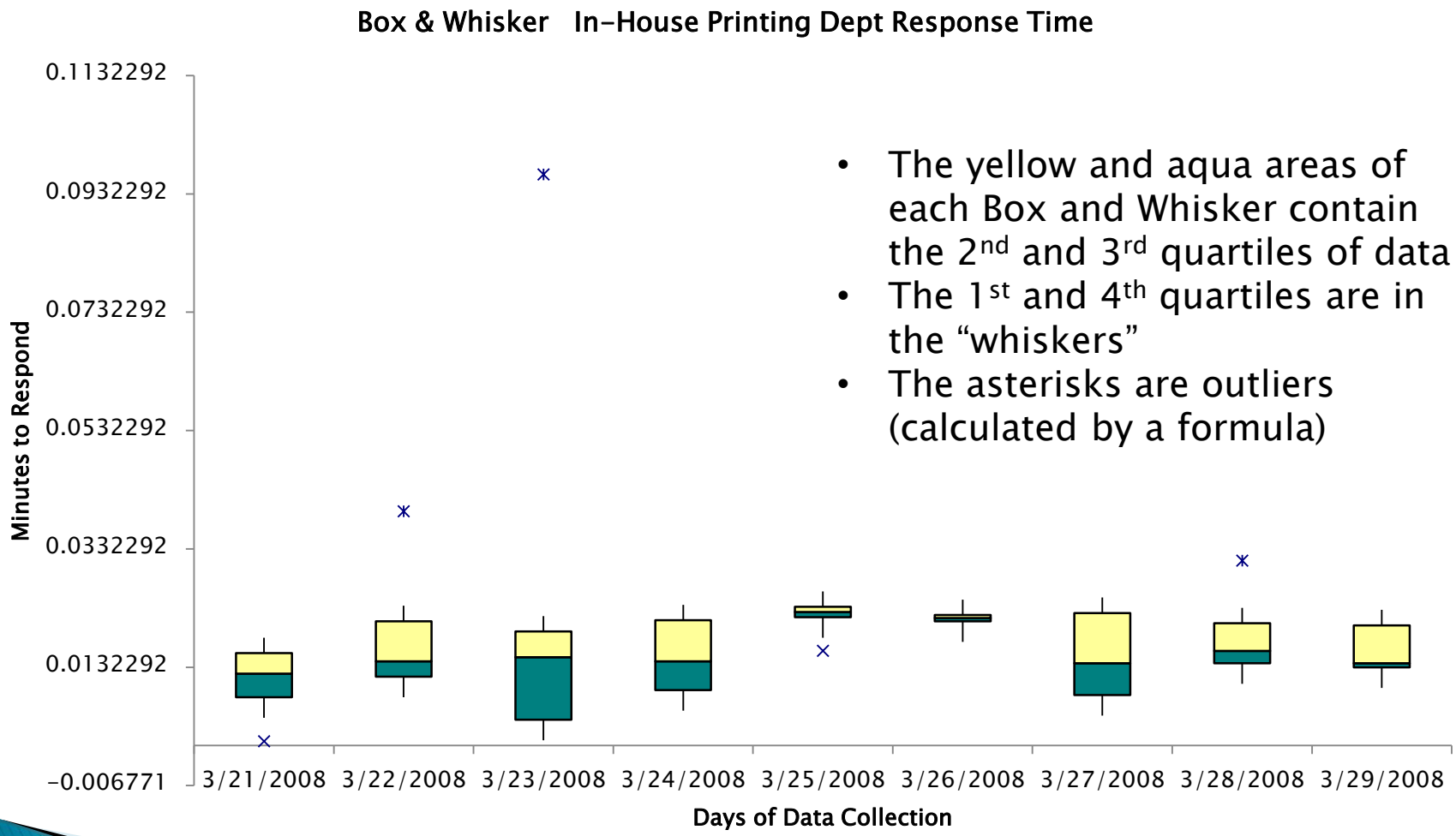
Possible Graphical Tools

- You have already seen:
  - Pareto Diagram
  - Run Charts
  - Histograms
  - Control (SPC) Charts
- We will introduce:
  - The Box and Whisker Plot

Other tools on QI Macros include:

Dot Plots
Scatter Plots
Multi-Vari Charts
Values Plot

Box and Whisker Plots



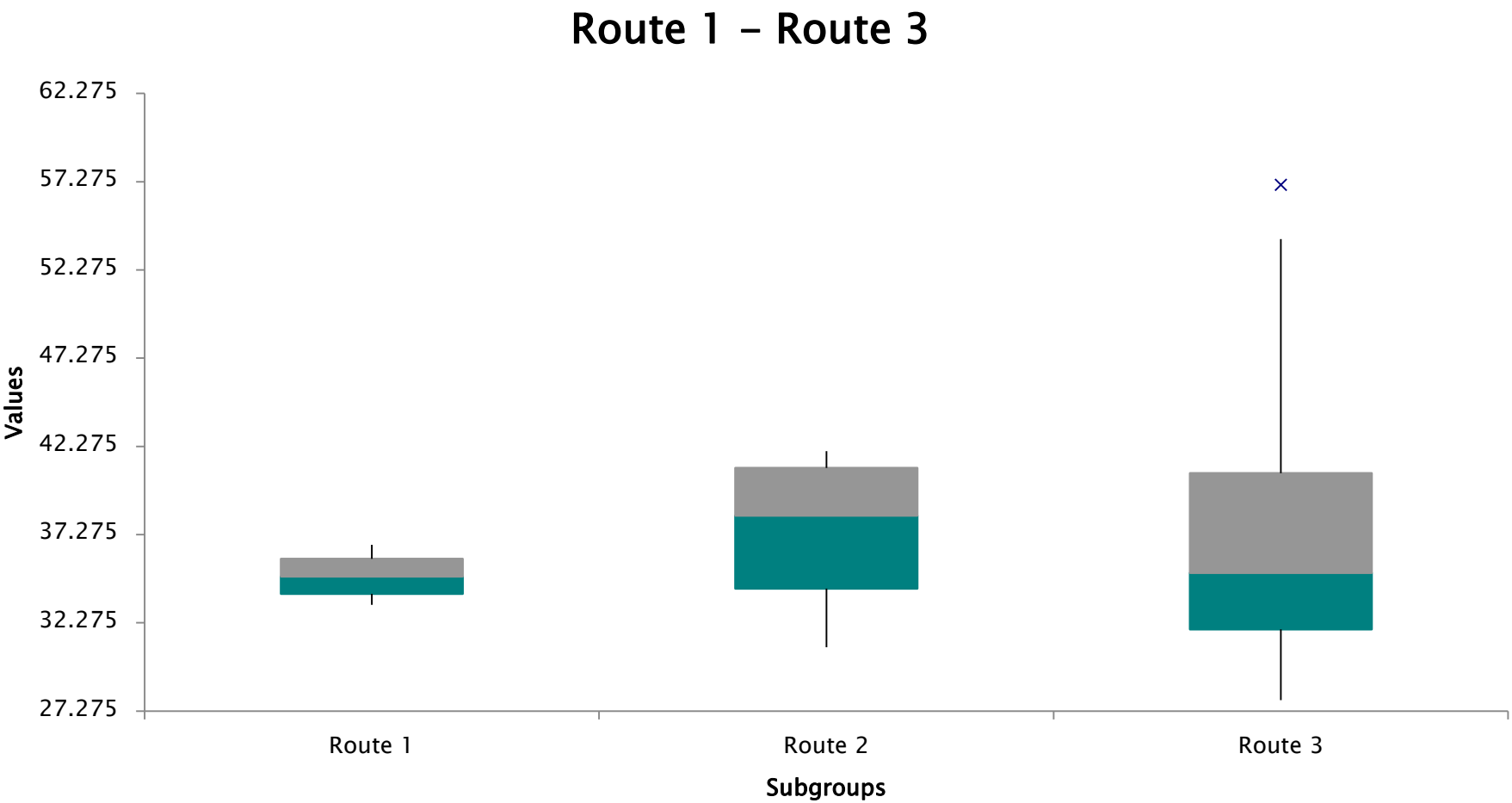
- The yellow and aqua areas of each Box and Whisker contain the 2nd and 3rd quartiles of data
- The 1st and 4th quartiles are in the "whiskers"
- The asterisks are outliers (calculated by a formula)

B&W

Exercise – Box and Whisker

- As part of your analysis you try different routes to see if they make a difference graphically
- Use the file B&W to generate a Box and Whisker plot
  - Highlight A, B and C
  - Run Box, Dot & Scatter > Box and Whisker
  - Select “Columns” on the “Group by…” dialogue box
  - Click OK on the titles

Box and Whisker – Results

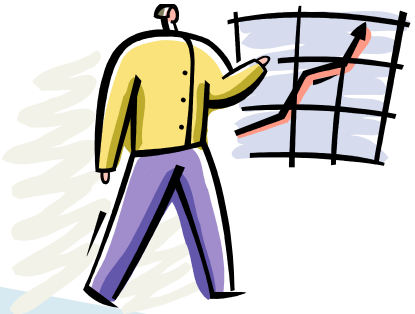


What observations can you make?
Which appears to be the best route? Why?

Statistical Tools

Simple Linear Regression (SLR)

- Measures the strength of association between the input and the output
  - $Y = f(x)$
- The simplest tool for determining the effect on the output based on a change in the input
- Based on your high school math
  - $Y = mx + b$ (where "m" is the slope and "b" is the y-intercept)



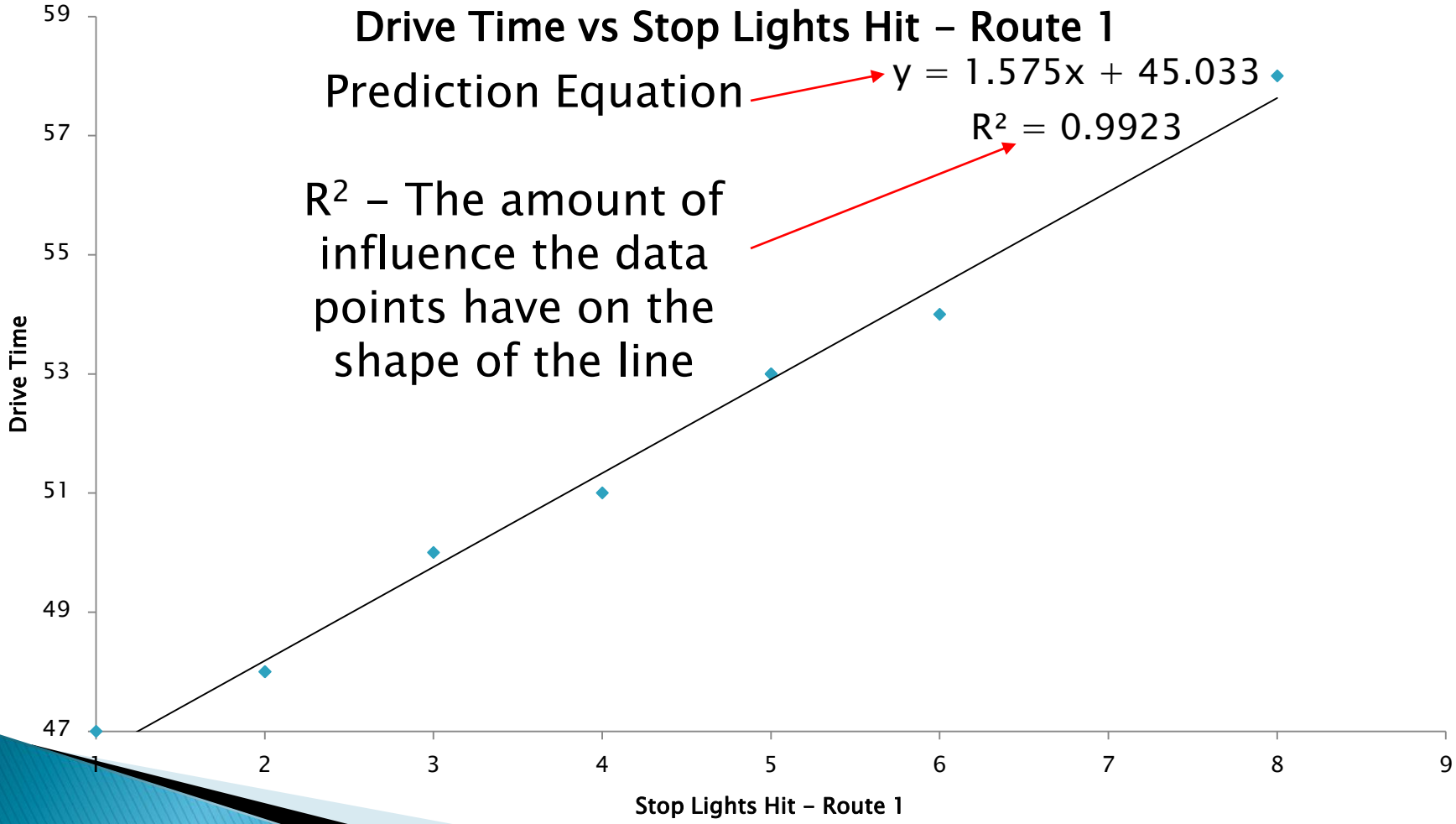
Exercise – Simple Linear Regression

SLR

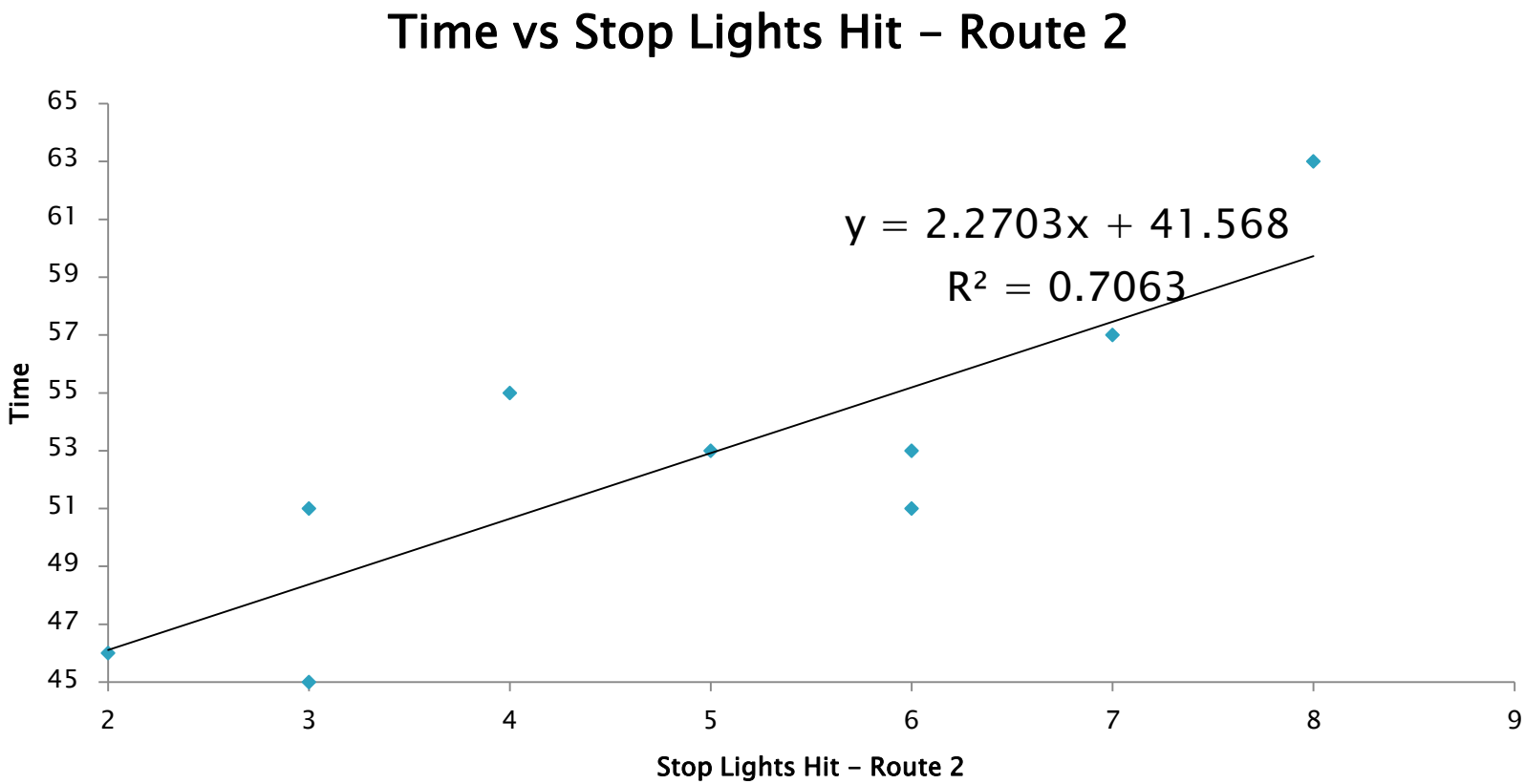
- Follow along using the file SLR to analyze the drive time versus the number of stop lights hit while taking two different routes to work

- Open file SLR
- Highlight columns A and B (route 1)
- Run Box, Dot & Scatter Plot > Scatter
- Click OK through the title slides
- Repeat on columns D and E (route 2)

Simple Linear Regression – Results for Route 1



Simple Linear Regression – Route 2



Compare the graphs. What observations can you make?

Questions

- If I hit no stop lights, which has the shortest drive time?
- If I assume that I will hit an average of 5 stop lights each day, how long will the trip take for each route?
- If I hit 8 stop lights, which route has the shortest drive time?

Hypothesis Testing

Hypothesis Testing

- Use to statistically determine if there are differences between a sample and a target or between two or more sample groups
- Used to determine whether making a change to the input variable will result in changes to an output
- Without hypothesis testing teams may make adjustments that are not actually required
  - These knee jerk responses can amplify variation and cause additional problems

Hypothesis Testing

- In manufacturing, you might want to compare two or more raw materials and determine if they produce the same quality
- Hypothesis testing helps identify ways to reduce cost and improve quality

The Hypothesis Test

- Define a null (Ho) and an alternative (Ha) hypothesis
  - Ho = the sample is the same as the target or the samples are the same
  - Ha = at least one of the samples are different from the target or other sample(s)
- There are hypothesis tests for means, medians, proportions, variance and dependence
- The goal is to prove that they are not statistically the same *at some level of confidence* (usually 95%, 99%)

Hypothesis Testing Methods

- Three types of Hypothesis testing
  1. Classical Method – comparing a test statistic to a critical value (very statistically oriented)
  2. ***p value Method – the probability of a test statistic being contrary to the null hypothesis***
     - <u>If the p value is equal to or greater than the α value (or level of significance), the null hypothesis is confirmed (remember sample sizing)</u>
  3. Confidence Interval Method – is the test statistic between or outside of the confidence interval (used for target values)

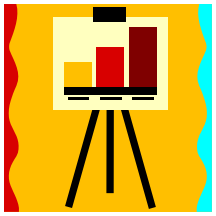
P-Value Use Explained

- The p-value is the probability that your conclusion of the null hypothesis is incorrect (e.g. your results are highly unlikely to occur in a real world)
  - Keep in mind: the data is not good or bad, it just does not fit your hypothesis
  - You may not have enough data in your sample to prove your original hypothesis

Normality and Variance in Hypothesis Testing

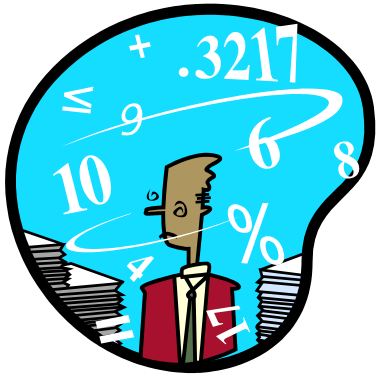
- Run Normality first on ALL variable data
  - T tests and ANOVA are used for normal data
    - Note: samples are run separately and each sample set must be normal to run these tests
  - Non-Parametric tests are used for non-normal data

- F tests – run equal variance tests when comparing two or more samples
  - Bartlett's – test for equal variance for normal data
  - Levene's – test for equal variance for non-normal data



Most Common Tests

- Normality (Variable)
  - Testing for normality of the data
- F Test (variable)
  - Comparing variances (normal and non-normal)
- t-Tests (variable)
  - Used for comparing means
- ANOVA
  - Used for comparing more than two means
- Non-Parametric (variable)
  - Used to analyze non-normal data
- Proportion (attribute)
  - Used to analyze proportions
- Chi Squared (attribute)
  - A test of the dependency between input and output
  - Excellent for transactional processes



Roadmap for Hypothesis Testing – Normal Data

Analyze 4 – Hypothesis Roadmap

- Normality – normality of data
  - Statistical Tools > Descriptive Statistics – Normality Test
- Tests for Equal Variance of Multiple Samples
  - Statistical Tools > F Test: Two sample for variance (normal data)
  - Statistical tools > Levene's test for variance (non normal data)
- Mean
  - 1 sample t test – Statistical Tools: > t test one sample
    - Comparing one sample to a target
  - 2 sample t test – Statistical Tools > T test; two sample assuming equal variances
    - Comparing two samples
  - ANOVA Single Factor – Statistical Tools > Anova single factor
    - Comparing three or more samples

Roadmap for Hypothesis Testing – Non Normal Data

- Non Parametric (for non normal data)
  - Statistical Tools > Stat Templates > 1 sample sign
    - Comparing sample data versus target
  - Statistical Tools > Stat Templates > Mann Whitney
    - Comparing two samples of data
  - Statistical Tools > Stat Templates > Kruskal Wallis
    - Comparing three samples of data

Roadmap for Hypothesis Testing – Attribute Data

- Proportion Tests
  - Attribute data
  - Statistical Tools > 1-2 Proportions Test

- Chi Square Test
  - Dependence / Independence of the interaction between inputs and outputs
  - Statistical Tools > Chi Squared

B&W

Sample Exercise – 2 sample t Test

- You want to check and see if two different routes have different drive times.
  - Use columns B and C from the file B&W to determine if they are statistically different
    - Go to the Statistical Tools > Descriptive Statistics – Normality Test for means

Normality Results

Route 2

Route 2	Anderson-Darling	Data is Normal
38.0	A-Squared	0.359
41.5	*p*	0.375
42.0	95% Critical Value	0.787
30.9	99% Critical Value	1.092

Route 3

Route 3	Anderson-Darling	Data is Normal
31.9	A-Squared	0.561
41.1	*p*	0.109
39.7	95% Critical Value	0.787
41.4	99% Critical Value	1.092

The p-value is preset to be 5% or 0.05 for the normality test; both p-values are greater than 0.05 so we accept our null hypothesis that the data is normal

Testing for Equal Variance

- Run the proper test for equal variances
  - Go to Statistical Tools > F Test; Two-sample for variance
    - If one or both were not normal, you would have run Levene's test for variance instead
  - Keep the significance at 0.05 and click OK on the titles

F-Test Two-Sample for Variances	α	0.05				
	Route 2	*Route 3*				
Mean	37.38	37.12				
Variance	16.64178	72.21067				
Observations	10	10				
df	9	9				
F	0.23					
P(F<=f) one-tail	0.020	0.040	Two-tail			
F Critical one-tail	3.18	4.03	Two-tail			
One-tail	Reject Null Hypothesis because p < 0.05 (Variances are Differe					
Two-tail	Reject Null Hypothesis because p < 0.05 (Variances are Differe					

Conclusion: The variances are different

Results – 2 sample t Test

- Go to Statistical Tools > t Test: Two-sample assuming unequal variances

t-Test: Two-Sample Assuming Unequal Variances	α	0.05
Equal Sample Sizes		
	Route 2	*Route 3*
Mean	37.38	37.12
Variance	16.64178	72.21067
Observations	10	10
Hypothesized Mean Difference	0	
df	13	
t Stat	0.087	
P(T<=t) one-tail	0.466	
T Critical one-tail	1.771	
P(T<=t) two-tail	0.932	
T Critical Two-tail	2.160	

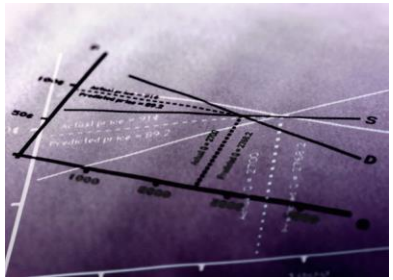
Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)

Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)

Chi Square

Attribute Testing with Chi Square

- Chi Square testing is used to see if the results are independent or dependent on an input
  - The null hypothesis is that they are independent (p-value $> \alpha$)
  - Chi Square testing is excellent for analyzing survey data
- Open file Chi Square
- Highlight columns A, B, C and D
- Statistical Tools > Chi Squared



Chi Squared Results

	21-40	41-60	60+	Total		
Like	27	12	24	63	**Chi-Sq**	**18.31879241**
Don't Care	35	67	31	133	***p***	**0.001069037**
Hate	13	21	17	51	α	0.05
Total	75	100	72	247	Variables are Related	
	21-40	41-60	60+	Contribution		
Like	3.238126084	7.15178716	1.729451835			
Don't Care	0.717948718	3.213296703	1.556929182			
Hate	0.399032574	0.006008573	0.306211576			

The highest contribution comes from the interaction that is least expected

- This gives you clues about the population

A p-value less than 0.05 tells you that the variable and the output ARE dependent!

Attribute Testing of Proportions

- Your historic defect rate has been 5.4%. You have made some improvements and want to see if that is been reduced. You collect 154 samples and there are 5 defects. You declare success based on your new 3.2% defect rate. Based on this sample, have you really made a difference?
  - Open a blank Excel Spreadsheet
  - Statistical Tools > 1-2 Proportions Test
  - Choose the tab labeled "One Proportion"
    - Enter 0.946 (success rate) in the yellow box of column A
    - Enter 154 in the yellow box of column B (trials)
    - Enter 149 in the yellow box of column C (successes)
    - Keep the confidence level at 0.95 ($\alpha = 0.05$)

1 Proportion vs. Target – Results

				0.95	Confidence Level				
Proportion	Trials	Successes	Sample p	95% Confidence Intervals		*p (Direct)*		*p (Normal)*	
0.946	154	149	0.967532	0.925860	0.989375	0.154	H1<>H0	0.237	H1<>H0
				0.93954	0.995525	0.077	H1>H0	0.119	H1>H0
						0.923	H1<H0	0.881	H1<H0

Look for the Red colored boxes in the *p (normal)* area. The sample is NOT different from the historical average!

It shows the p-values for all three of the Possible scenarios:

- Sample (H1) = Historic Proportion (H0)
- Sample > Historic Proportion
- Sample < Historic Proportion

Note the p values are all greater signifying that the Null Hypothesis is true. If any of the p values were less than 0.05 it would signify a relationship that was not true (e.g. H1<H0)

Try gathering More Data… More data gives a more accurate number

Analyze Phase Tollgate Checklist

Champion Analyze Phase Checklist

Analyze Phase	Comments
What are your deliverables for this phase? Summarize the findings.	
Has your Problem Statement or Objective Statement changed? If yes, why?	
Have you completed you Fishbone (Ishikawa) analysis to identify variable in our process?	
How many significant (vital few) variables influence the process and what are they? What sources of variation have been identified?	
Have you started your FMEA?	
Have you performed any Root Cause Analysis on your process?	
Have you done any Graphical Analysis to identify key input varibles in your process?	
Have you completed any regression analysis?	
Have you confirmed any findings using Hypothesis Testing? What are the conclusions?	
What is the potential contribution of each of the vital few variables?	
What interim actions have you taken to contain defects until a final solution can be developed and implemented? Has the FMEA been completed?	
What tools have you used in this phase and how were they helpful?	
What are your improvement plans (containment actions and long term solutions) and next steps to get there (including timing, responsibility and expected results)?	
Has your COPQ changed?	
What are you conclusions from this phase?	
Are you on track to meet the scheduled completion date?	
Are you satisfied with the level of cooperation and support you are getting?	
Have you obtained the signatures from leadership to move on to the next phase?	

Analyze Phase Tollgate Checklist

Project Team Analyze Phase Checklist

Analyze Tollgate Approval	
	Champion Approval Signature/Date:
Tollgate review approved unconditionally:	
Tollgate review approved with the following contingencies:	
Tollgate review dis-approved, list issues for resolution:	

Analyze Phase Questions?