
Lean Six Sigma Statistical Tools in Healthcare

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Speaker Introduction

Richard has over 23 years of continuous improvement experience. He has held roles in Quality Assurance, Supplier Development, Continuous Improvement, Product Realization, and Operations. His career has focused on reducing non-value added activities and process variation using CI approaches including Lean Six Sigma, VA/NVA, Value Stream Mapping, Theory of Constraints, 5S, and Kaizen. Richard has held positions with Toyoda Gosei, United Technologies, ArvinMeritor, Trelleborg, Superior Industries, and Gates Corporation and currently serves clients in the Automotive, Aerospace, Industrial, Nuclear, Food Service, and Consumer Products industries. He is an Adjunct Instructor at Northwest Arkansas Community College, Tulsa Technology Center, Francis Tuttle Technology Center, and is a Master Black Belt for CI Solutions, LLC. He is an ASQ member, ASQ Certified Six Sigma Black Belt, and ASQ Six Sigma Forum Advisory Council Member. He and his wife, Sheila, have four children and live near Bentonville, Arkansas.

Healthcare Finance Management

- Vitally important to organizational success!
- Healthcare is a “data-rich” environment.
- Analytical opportunities include both simple and complex methods (practices and tools)

Organizational Success

- Organizational success depends largely on effective strategic decision making and problem solving.
- Too often, organizations make decisions based on limited or anecdotal information, incomplete analysis, small data sets, and averages.

Why Use Six Sigma Stats Tools?

- Averages and small data sets do not tell the whole story! What about variation?
- Finding true causes can be confusing and hard!
- Organizations using Lean Six Sigma Statistical Tools to support decision making and problem solving have avoided costly mistakes.
- Many have experienced reduced costs and increased profitability as well as expanded capacity.

Disclaimer

The background story, information, and data presented here is for demonstration of Six Sigma statistical tools only and IS NOT an actual case study.

Any similarity to actual organizations or individuals is unintentional and purely accidental.

All statistical analysis presented here was completed using Minitab 17.3.1. This is not an endorsement or advertisement for Minitab.

Background Story

Alpha Risk Medical Management (ARMM) is a healthcare management and investment firm. ARMM has purchased several local practices and hospitals to form 12 regional hospitals around the U.S.

With hospitals, labs, and offices around the country, financial management is a top organizational function. The CFO estimates that ARMM left over \$12 Million on the table in fiscal 2016 due to rejected, delayed, or unpaid claims.

A recent audit of 5000 medical bills indicated that 76% contained errors.

As we know, insurance companies have very strict requirements for billing and coding, and claims are frequently rejected due to simple errors.



Background Story (cont.)

When claims are rejected, a long and costly process begins. The provider must correct the error, resubmit the claim, and wait for the claim to be accepted and processed. This may delay payment for several weeks or months.

The delay in payment, investigation costs, correction costs, and unpaid claims add up throughout a year. Additional costs include lost opportunity because some amount of our capacity is consumed with managing billing errors instead of treating patients.

ARMM's leadership team has asked the CFO to lead a team to investigate and address the causes of lost revenue due to billing errors throughout the organization. She has chosen to build a team that includes a Lean Six Sigma Black Belt and members from all ARMM hospitals.



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Lean Six Sigma Overview



Most Lean Six Sigma projects will follow the DMAIC structure.

- Standard approach
 - Five (5) phases
 - Team-based
 - Data-focused problem solving

Define

Measure

Analyze

Improve

Control

DMAIC



What are the DMAIC phases?

Define the problem with your product or process.

Measure your current process and collect data.

Analyze your data to find the problem's root causes.

Improve your process by implementing and verifying corrective actions.

Control your new process and monitor it over time to hold the gains.

Define

Measure

Analyze

Improve

Control

Define

Measure

Analyze

Improve

Control

Define

Measure

Analyze

Improve

Control

Define

Measure

Analyze

Improve

Control

Define

What is the problem with your product or process?

Make the business case to justify the project.

Define Phase



The Lean Six Sigma journey:

- ✓ Starts with a problem
- ✓ Defines the customer
- ✓ Explains how the problem impacts the business
- ✓ Defines the process scope
- ✓ Identifies when the problem is solved
- ✓ Answers how success is measured & maintained

The primary output of Define is a complete and approved Project Charter to begin the project.

Types of Problems



- ✓ A donated liver is thrown away.
- ✓ A paid-off house is foreclosed on.
- ✓ Vaccine recalled for contamination.
- ✓ An automobile is recalled for accelerator issue.
- ✓ Automotive parts are rejected as off color.
- ✓ Shirts are rejected for being too small.
- ✓ Cell phones catching fire while charging.
- ✓ Billing error rate too high.

(Possible DMAIC Project Motivators)

Problem Statement

The CFO estimates that ARMM left over \$12 Million on the table in fiscal 2016 due to rejected, delayed, or unpaid claims.

A recent audit of 5000 medical bills indicated that 76% contained errors.

Note: “Bills” are the statements received by the patient and includes one or more transactions (records).



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Define

Measure

Analyze

Improve

Control

Measure

Measure your current process and collect data.
Validate the measurement system.
Establish initial process capability.

Measure Phase



The Lean Six Sigma journey continues:

- ✓ What do we need to measure?
- ✓ How do we measure them?
- ✓ Are we using suitable measurement systems?
- ✓ What is our performance specification?
 - ✓ What performance is expected?
- ✓ What is the baseline process performance?

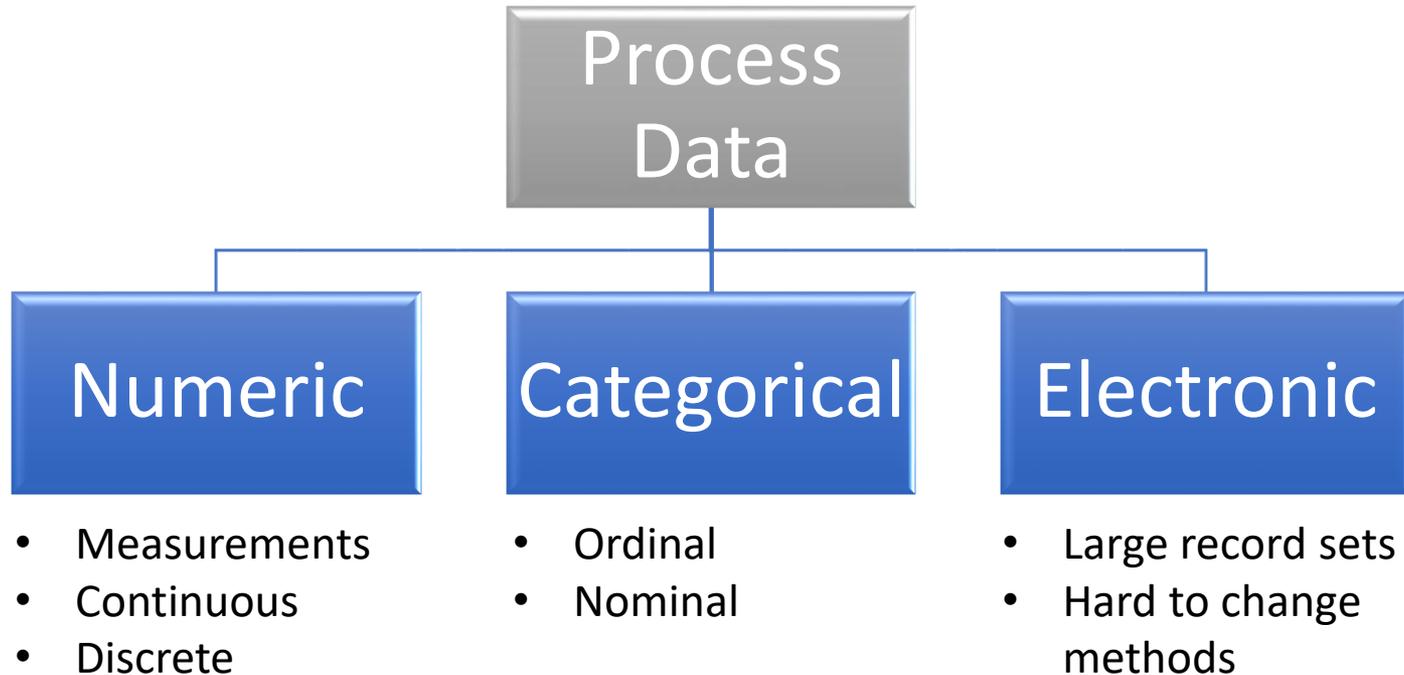
Data Collection Tools



1. Records and Secondary Data
2. Observations (Tally sheets, Measurements)
3. Surveys and Interviews
4. Focus Groups
5. Diaries, Journals, Checklists, Check sheets
6. Expert Judgment
7. Integrated Systems (Databases)

Data Types

Process data falls into one of 3 major types:



Validated by Gage
R&R Study

Validated by
Attribute
Agreement Analysis

Validated by review
for missing entries,
datatype mismatch,
etc.

Billing Records Data

The team pulled a random sample of patient records from all 12 regional hospitals for June through August for review...

↓	C1	C2	C3-T	C4-T	C5-T	C6-T	C7	C8	C9-T	C10-D	C11-T	C12-T
	ClaimNum	Value	Hospital	Region	Type	Union	Software	StafftoPatientRatio	Volunteer	ServiceDate	Month	Day
1	244163	283.208	Main	Mid West	FP	NonUnion	1999	0.0980	Yes	8/11/2015	Aug	Tue
2	239429	244.995	Liberty	Northwest	FP	Union	1998	0.0862	No	8/23/2015	Aug	Sun
3	160346	164.011	Liberty	Northwest	FP	Union	1998	0.0862	No	8/12/2015	Aug	Wed
4	192291	143.816	Generations	West Coast	NFP	NonUnion	2015	0.1550	Yes	8/1/2015	Aug	Sat
5	240543	210.695	Milsap	East Coast	FP	Union	2000	0.1111	No	7/23/2015	Jul	Thu
6	194526	-9.032	Madison City	West Coast	FP	Union	2014	0.1404	Yes	6/15/2015	Jun	Mon
7	147859	231.562	Gotham	East Coast	NFP	Union	2002	0.1587	Yes	6/19/2015	Jun	Fri
8	241688	280.067	Milsap	East Coast	FP	Union	2000	0.1111	No	8/2/2015	Aug	Sun
9	142157	346.636	Liberty	Northwest	FP	Union	1998	0.0862	No	8/27/2015	Aug	Thu
10	241544	247.218	Milsap	East Coast	FP	Union	2000	0.1111				
11	120255	68.273	Old Town	Central	NFP	NonUnion	2016	0.1640				
12	151198	372.766	Gotham	East Coast	NFP	Union	2002	0.1587				
13	148440	344.923	Gotham	East Coast	NFP	Union	2002	0.1587				
14	127576	242.995	Main	Mid West	FP	NonUnion	1999	0.0980				
15	138172	185.861	Old Town	Central	NFP	NonUnion	2016	0.1640				
16	178576	119.582	Generations	West Coast	NFP	NonUnion	2015	0.1550				
17	128674	221.438	Main	Mid West	FP	NonUnion	1999	0.0980				
18	144890	270.028	St. Vicks	Central	NFP	Union	2012	0.1639				
19	178652	73.083	Madison City	West Coast	FP	Union	2014	0.1404				
20	170.562	Jackson	Mid West	NFP	NonUnion	2008	0.1818					
21	173.613	Madison City	West Coast	FP	Union	2014	0.1404					

Name	Id	Count	Missi...	Type
StdOrder	C1	21287	0	N
ClaimNum	C2	21287	0	N
Value	C3	21287	0	N
Hospital	C4	21287	0	T
Region	C5	21287	0	T
Type	C6	21287	0	T
Union	C7	21287	0	T
Software	C8	21287	0	N
StafftoPatientRatio	C9	21287	0	N
Volunteer	C10	21287	0	T
ServiceDate	C11	21287	0	D
Month	C12	21287	0	T
Day	C13	21287	0	T



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Define

Measure

Analyze

Improve

Control

Analyze

Analyze your data to find the problem's root cause(s).
Identifying the 'vital few' inputs.

This is where we use the most statistical tools!

Analyze Phase



The third Lean Six Sigma phase:

- ✓ What are the possible causes for the problem?
- ✓ How do each of those possible causes affect process performance?
- ✓ What are the vital few x's (causes, inputs, etc.)?
- ✓ How can we identify the vital few?

Possible Causes



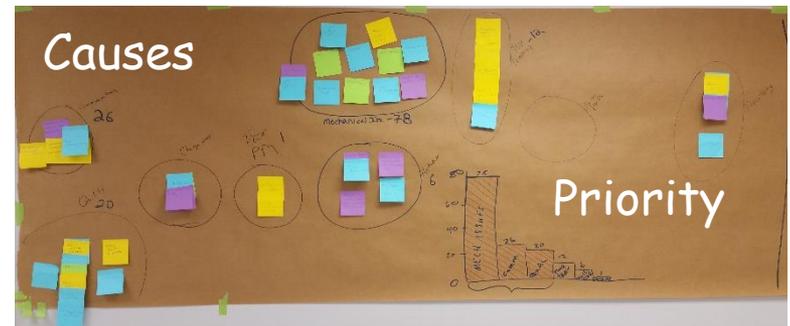
- ✓ Where do we start?
- ✓ Before we know what to fix, we must identify possible causes that lead to the problem.
- ✓ How can we do that?
 - Brainstorming
 - Review records & data
 - Ask experts; Go to Gemba!!!
 - Cause and Effect Diagrams
 - Affinity / Tree Diagrams

Brainstorming



✓ Silent Brainstorming is a simple method to collect a large amount of information from a group of team members quickly. Here's how:

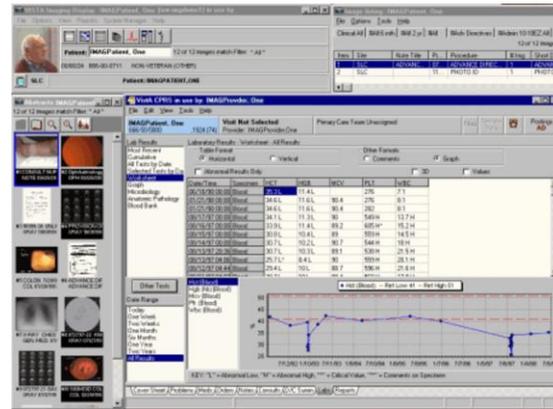
- State the 'Trigger Question'
- Set a 3-5 minute time limit
- Write 1 idea per sticky note
- No talking
- Be prolific..... Quantity!
- Put all post-its on the board
- Arrange post-its into groups
- Label the groups
- Discuss the groups and assign priority



Review Records



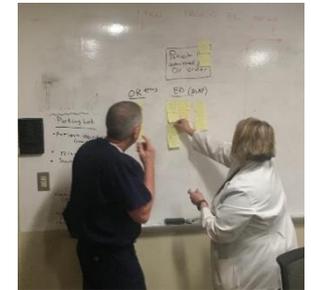
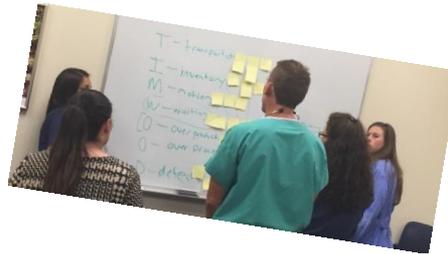
- ✓ Review any available records, both electronic and hardcopy if necessary
- ✓ It is important to define the time frame to review
- ✓ Recall the process scope! Avoid scope creep!



Go to Gemba!

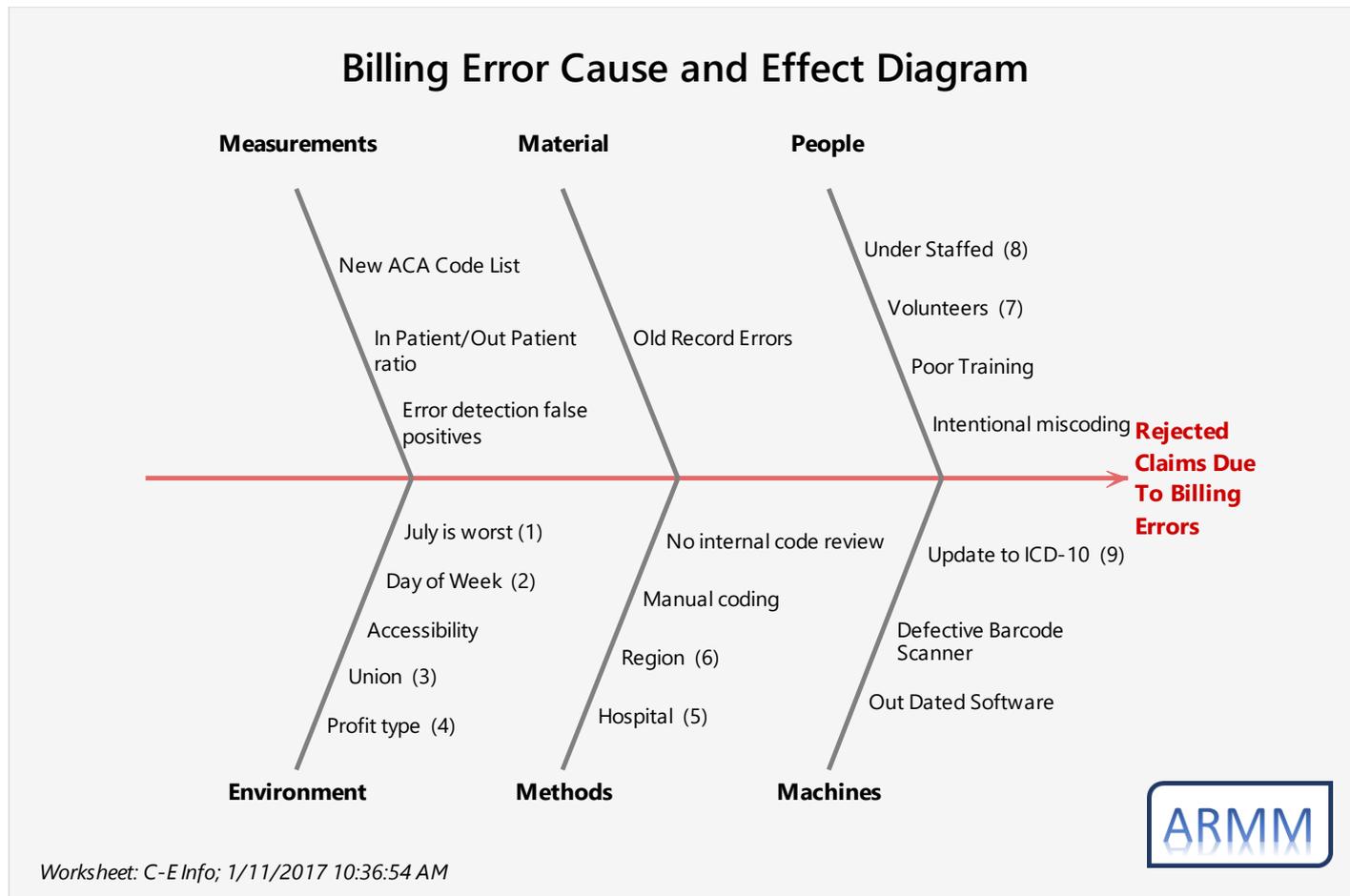


- ✓ The people who do the work (where the value is created) are a great source of root cause information.
- ✓ Their inputs often come through expressing their pain points and the conditions present when the problem occurs.
- ✓ When visiting Gemba, it is crucial that we take lots of notes and ask open-ended questions.

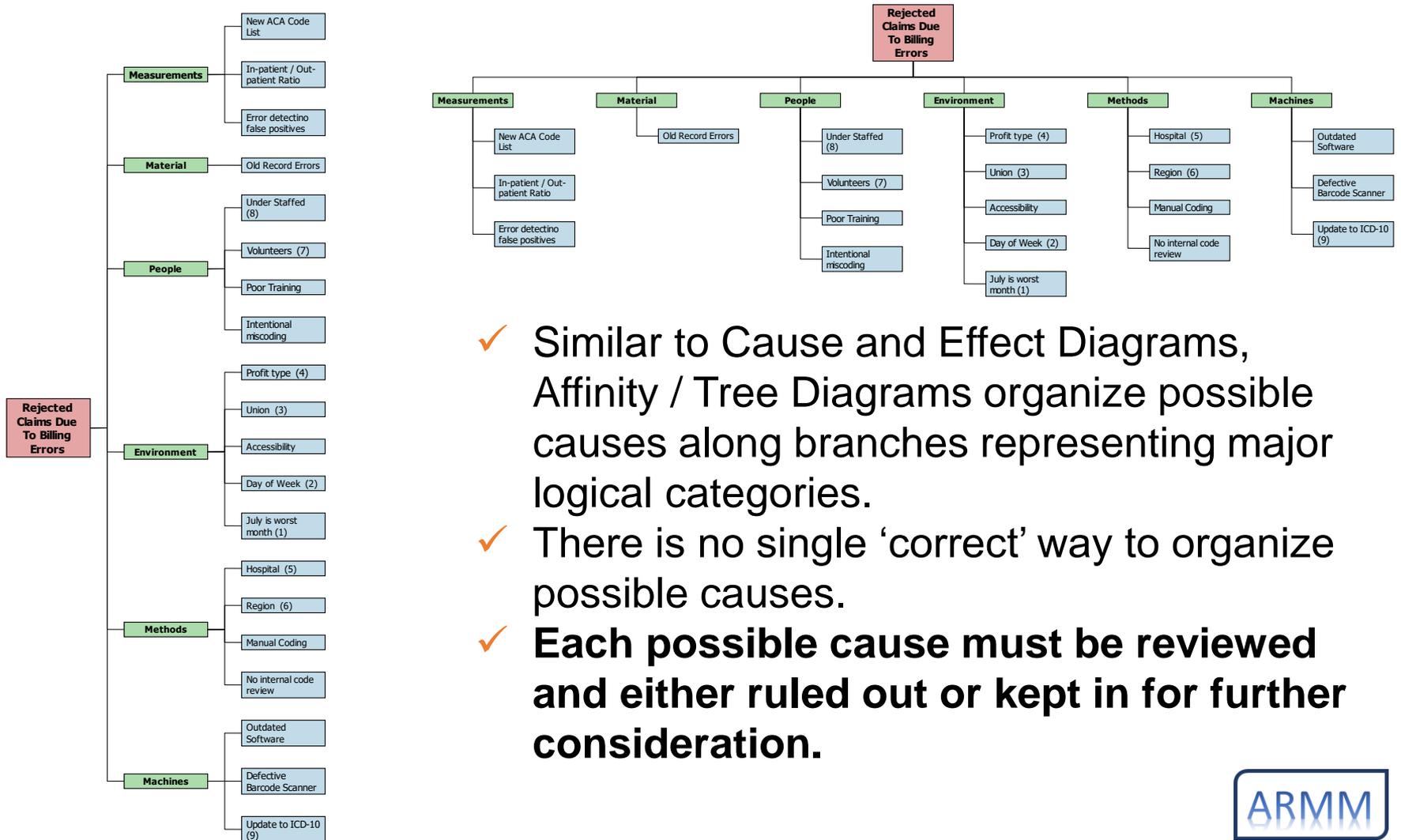


Cause and Effect Diagram

Sometimes referred to as Ishikawa Diagrams or Fishbone Diagrams.



Affinity / Tree Diagrams

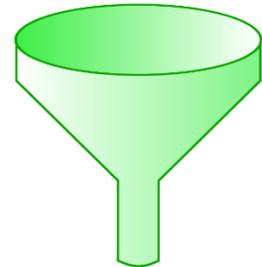


- ✓ Similar to Cause and Effect Diagrams, Affinity / Tree Diagrams organize possible causes along branches representing major logical categories.
- ✓ There is no single 'correct' way to organize possible causes.
- ✓ **Each possible cause must be reviewed and either ruled out or kept in for further consideration.**

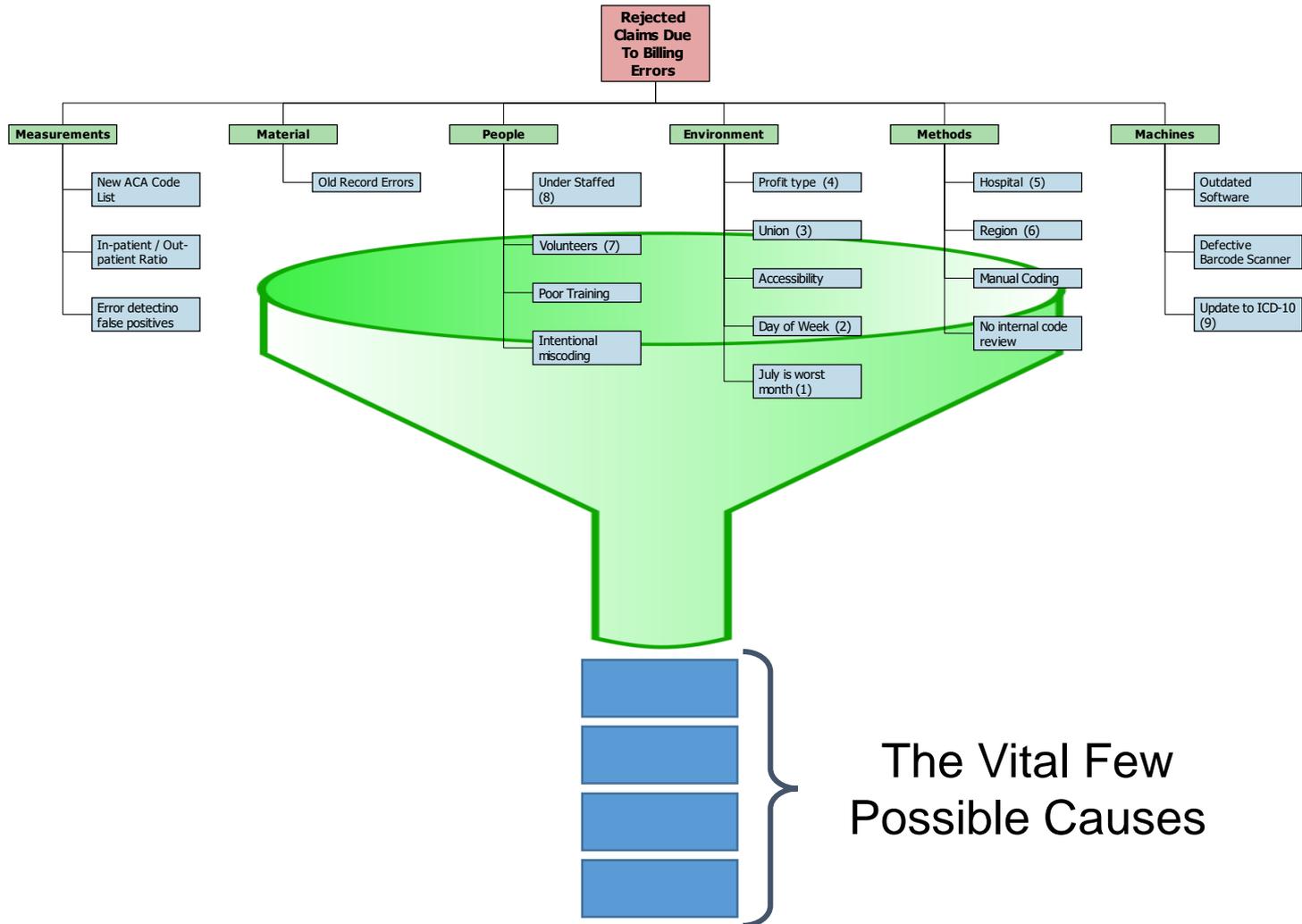
Possible Causes



- ✓ As we organize ideas of possible causes, our focus is to reduce the list of possible causes to the vital few process inputs (x's) that contribute the most to the occurrence of the problem.
- ✓ Hypothesis testing can be used to eliminate or confirm x's, define correlations, determine differences in groups of data, explain relationships between x's and y.



Identifying the Vital Few



Hypothesis Tests



- ✓ Common Hypothesis Tests:
- Graphical Summary
 - 1 Sample T test
 - 2 Sample T test
 - ANOVA test
 - Test for two % Defective (not shown here)
 - Chi-Square % Defective (not shown here)
 - Correlation test
 - Regression Analysis

Basic Steps in Hypothesis Testing

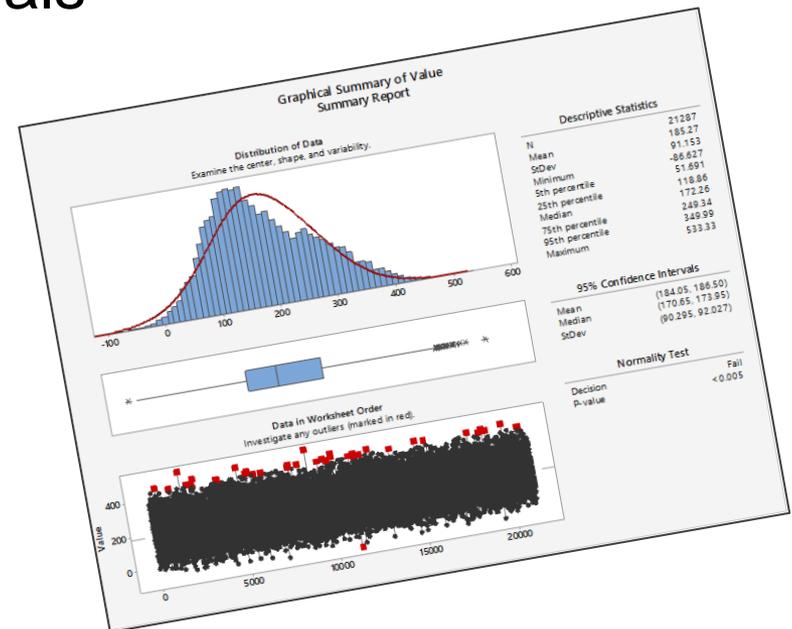
1. Define the problem and determine the objectives.
 - What question are we trying to answer?
2. Establish the hypothesis. (Null & Alternative)
3. State the risk levels (alpha & beta)
4. Decide on appropriate statistical test (assume distribution Z, t, F).
5. Establish the effect size (delta).
6. Determine critical statistic from the appropriate table.
7. Calculate test statistic (Z, t, or F) from the data.
8. State the Conclusion

Thankfully, we can use software like Minitab to help with steps 2-7!

Graphical Summary



- ✓ Not technically a Hypothesis Test, it is a collection of analytical information:
 - ✓ Descriptive statistics
 - ✓ Confidence intervals
 - ✓ Normality test



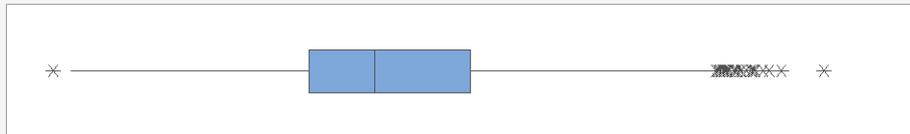
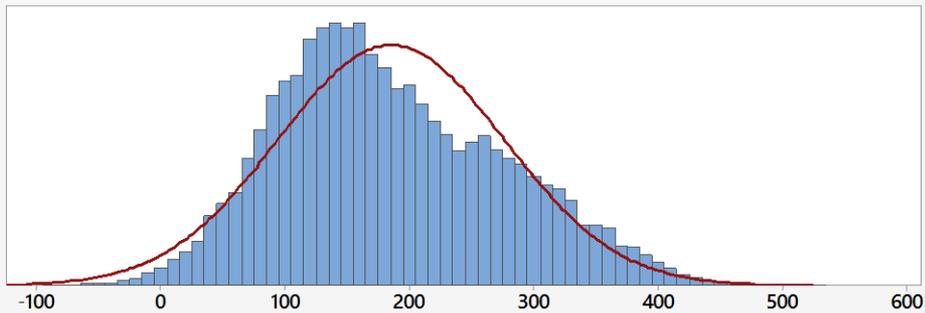
Graphical Summary

ARMM

Graphical Summary of Value Summary Report

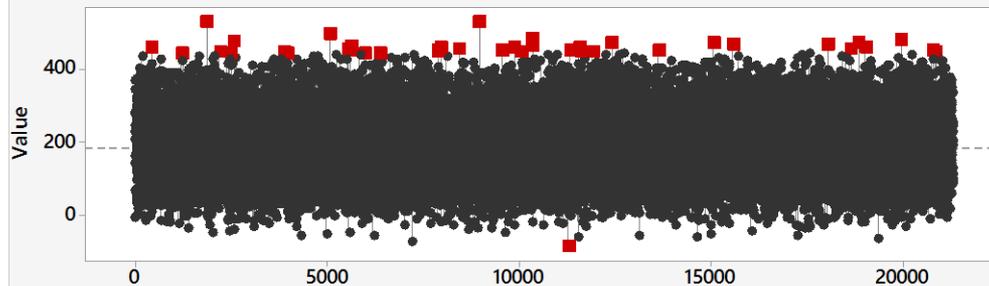
Distribution of Data

Examine the center, shape, and variability.



Data in Worksheet Order

Investigate any outliers (marked in red).



Descriptive Statistics

N	21287
Mean	185.27
StDev	91.153
Minimum	-86.627
5th percentile	51.691
25th percentile	118.86
Median	172.26
75th percentile	249.34
95th percentile	349.99
Maximum	533.33

95% Confidence Intervals

Mean	(184.05, 186.50)
Median	(170.65, 173.95)
StDev	(90.295, 92.027)

Normality Test

Decision	Fail
P-value	<0.005

1 Sample t Test



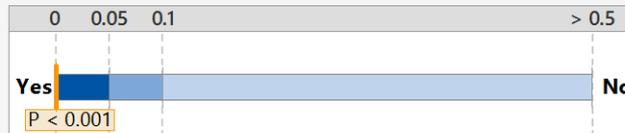
- ✓ This test compares the mean (average) and confidence interval of the values recorded in the record set to a known historical mean or, perhaps, a target value.
- ✓ Minitab's Assistant feature makes understanding this tool simple.
 - ✓ Descriptive statistics
 - ✓ Graphical display
 - ✓ Simple question
 - ✓ Comments
- ✓ Answers a question like:
 - ✓ *Does our process performance differ from the target of \$50 per rejected claim?*

1 Sample t Test

ARMM

1-Sample t Test for the Mean of Value Summary Report

Does the mean differ from 50?

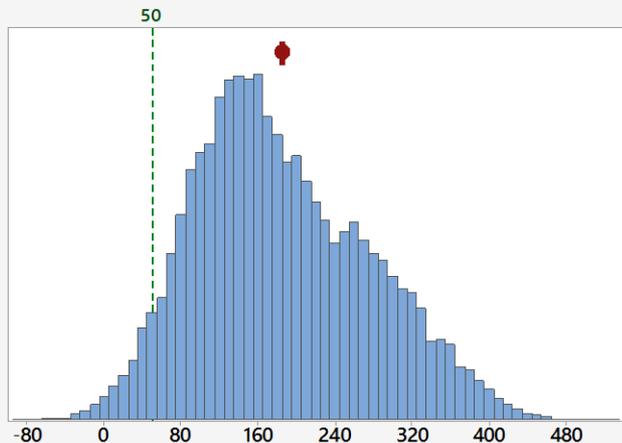


The mean of Value is significantly different from the target ($p < 0.05$).

Statistics

Sample size	21287
Mean	185.27
95% CI	(184.05, 186.50)
Standard deviation	91.153
Target	50

Distribution of Data
Where are the data relative to the target?

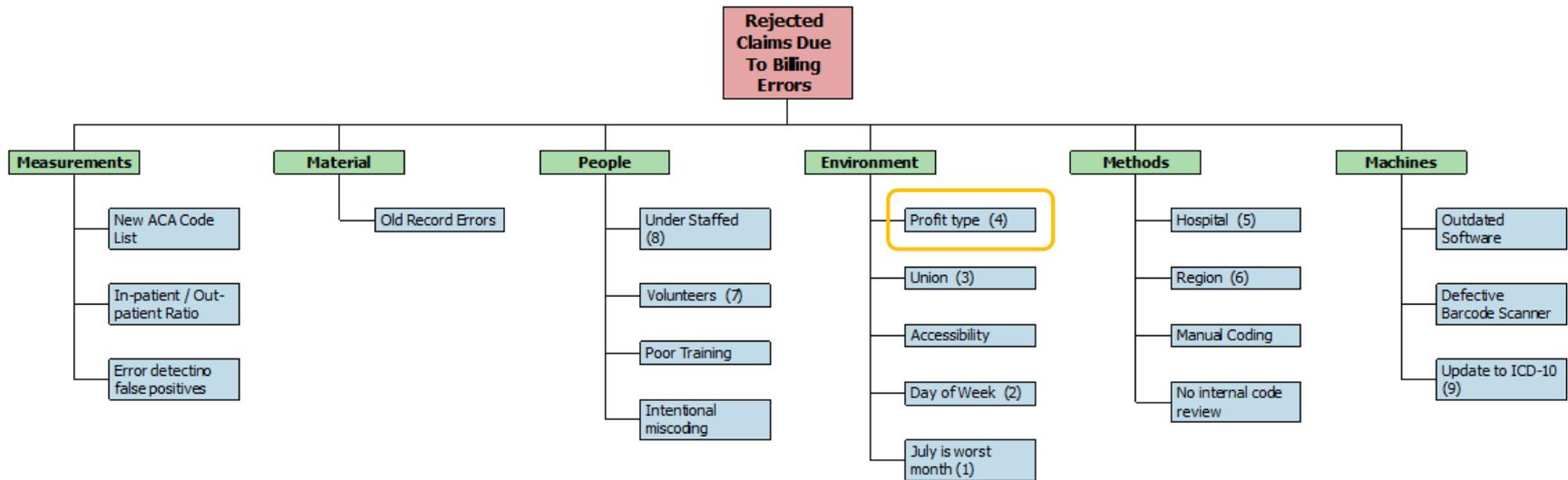


Comments

- Test: You can conclude that the mean differs from 50 at the 0.05 level of significance.
- CI: Quantifies the uncertainty associated with estimating the mean from sample data. You can be 95% confident that the true mean is between 184.05 and 186.50.

Based on this study, there is a statistically significant difference between the mean rejected claim value for all hospitals in this dataset and the target of \$50.

Possible Causes



- ✓ Since our process is not achieving the desired performance, we should review possible causes from the earlier brainstorming activity.
- ✓ Can we test any to either eliminate or confirm their importance?
 - ✓ Organization Type (FP / NFP)
 - ✓ Union vs. Nonunion
 - ✓ Use Volunteers or No Volunteers

2 Sample t Test



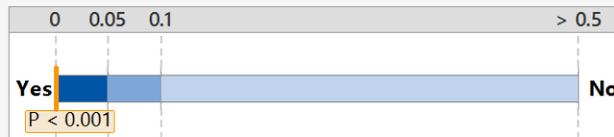
- ✓ This test compares the means (average) and confidence intervals of the values recorded in the record set for two groups (or subsets) within the whole record set.
- ✓ Again, Minitab's Assistant feature makes understanding this tool simple.
- ✓ Answers questions like:
 - ✓ *Is there a difference in the values of rejected claims from For Profit Hospitals compared to Not For Profit Hospitals?*

2 Sample t Test



2-Sample t Test for Value by Type Summary Report

Do the means differ?

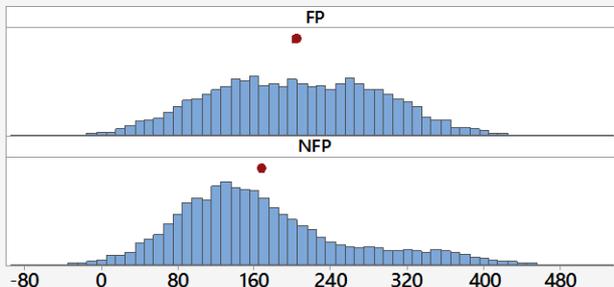


The mean of FP is significantly different from the mean of NFP ($p < 0.05$).

95% CI for the Difference
Is the entire interval above or below zero?



Distribution of Data
Compare the data and means of the samples.



Individual Samples

Statistics	FP	NFP
Sample size	10608	10679
Mean	203.09	167.58
95% CI	(201.4, 204.8)	(165.86, 169.29)
Standard deviation	88.290	90.507

Difference Between Samples

Statistics	*Difference
Difference	35.511
95% CI	(33.109, 37.913)

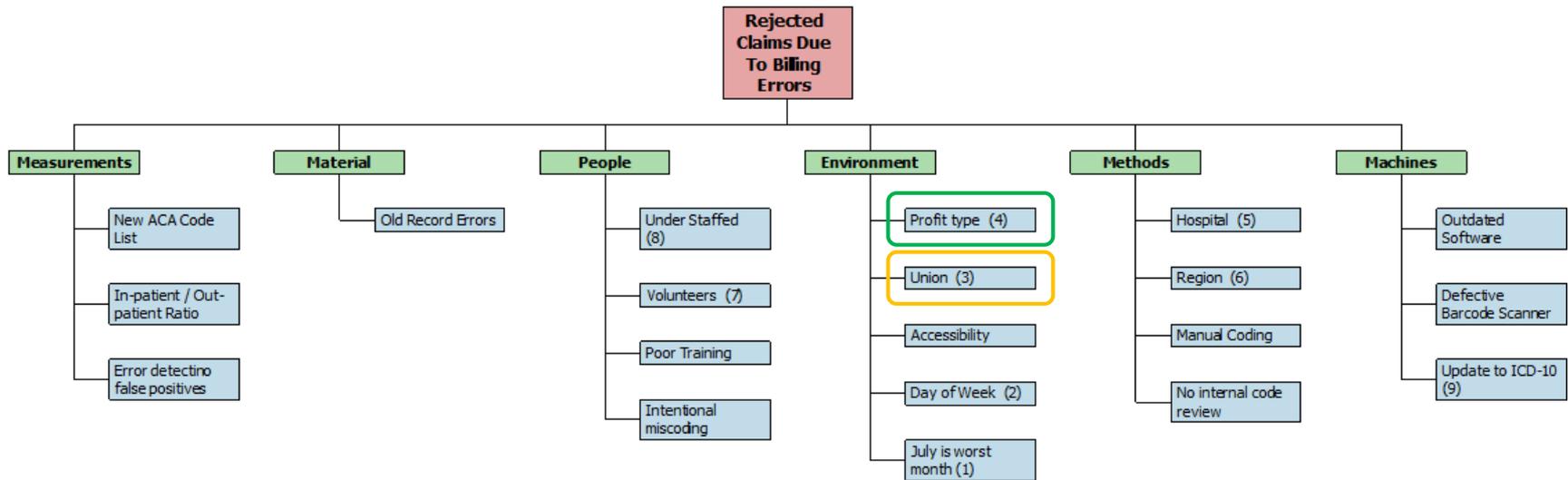
*Difference = FP - NFP

Comments

- Test: You can conclude that the means differ at the 0.05 level of significance.
- CI: Quantifies the uncertainty associated with estimating the difference in means from sample data. You can be 95% confident that the true difference is between 33.109 and 37.913.
- Distribution of Data: Compare the location and means of samples. Look for unusual data before interpreting the results of the test.

Based on this study, there is a statistically significant difference in the mean value of rejected claims between FP and NFP hospitals.

Possible Causes



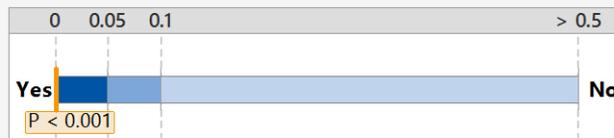
- ✓ We would use a 2 Sample t Test to check each possible cause that has 2 possible conditions?
 - ✓ Organization Type (FP / NFP)
 - ✓ Union vs. Nonunion
 - ✓ Use Volunteers or No Volunteers
 - ✓ Others...

2 Sample t Test



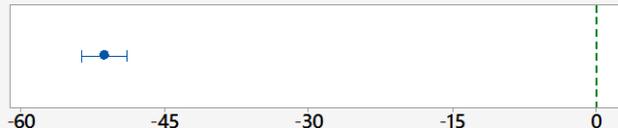
2-Sample t Test for Value by Union Summary Report

Do the means differ?

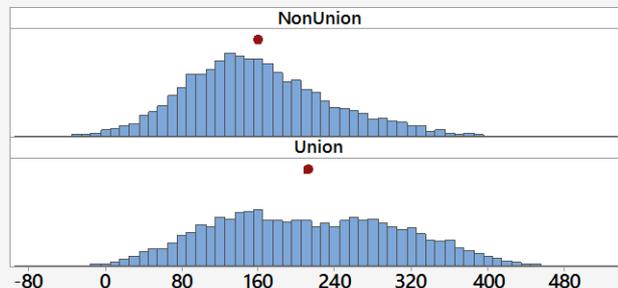


The mean of NonUnion is significantly different from the mean of Union ($p < 0.05$).

95% CI for the Difference
Is the entire interval above or below zero?



Distribution of Data
Compare the data and means of the samples.



Statistics	Individual Samples	
	NonUnion	Union
Sample size	10655	10632
Mean	159.62	210.98
95% CI	(158.2, 161.1)	(209.14, 212.83)
Standard deviation	76.717	97.045

Statistics	*Difference
Difference	-51.358
95% CI	(-53.709, -49.008)

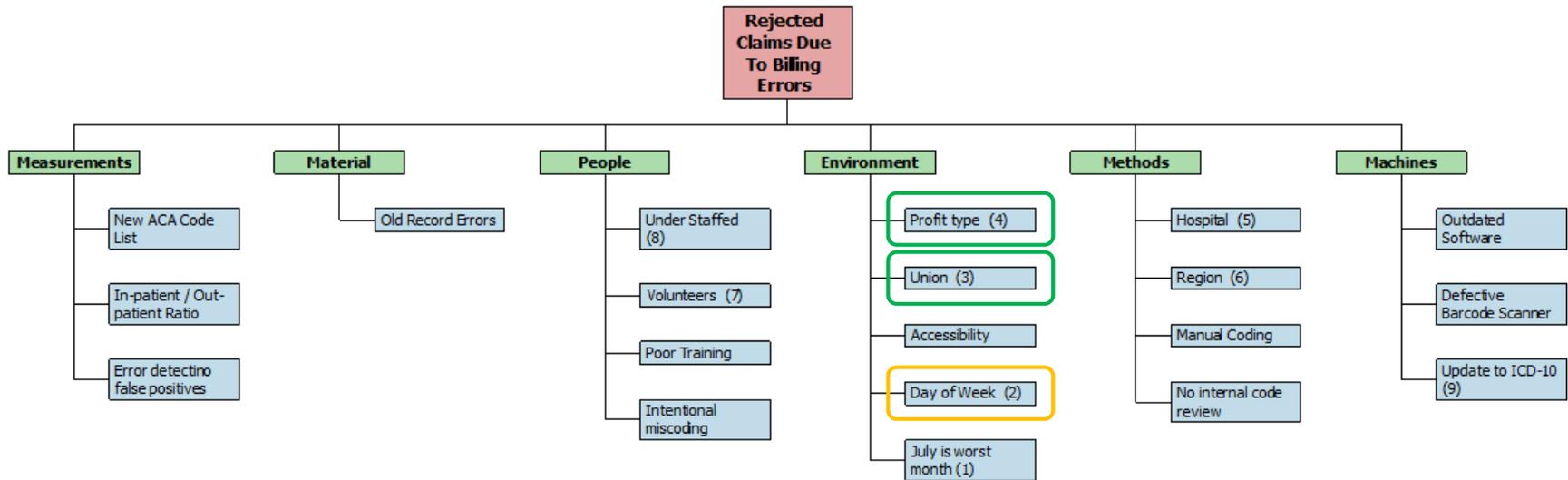
*Difference = NonUnion - Union

Comments

- Test: You can conclude that the means differ at the 0.05 level of significance.
- CI: Quantifies the uncertainty associated with estimating the difference in means from sample data. You can be 95% confident that the true difference is between -53.709 and -49.008.
- Distribution of Data: Compare the location and means of samples. Look for unusual data before interpreting the results of the test.

Based on this study, there is a statistically significant difference in the mean value of rejected claims between Union & Non Union hospitals.

Possible Causes



- ✓ We would use the 2 Sample t Test to either eliminate or confirm the importance of each possible cause that has only 2 possible conditions (FP vs NFP; U vs. NU; etc.)
- ✓ But what about other possible causes that have more than 2 conditions?
 - ✓ Day of the Week
 - ✓ Month of the Year

ANOVA can test more than 2 groups!

ANOVA



- ✓ This test compares the means and confidence intervals of the values recorded in the record set for more than two groups within the whole record set. Minitab can compare up to 12 groups.
- ✓ Again, Minitab's Assistant feature makes understanding this tool simple.
- ✓ Answers questions like:
 - ✓ *Are the rejected claims amounts different for some days compared to other days?*
 - ✓ *Are the rejected claims amounts different for some Regions or Hospitals compared to others?*

ANOVA Test



One-Way ANOVA for Value by Day Summary Report

Do the means differ?

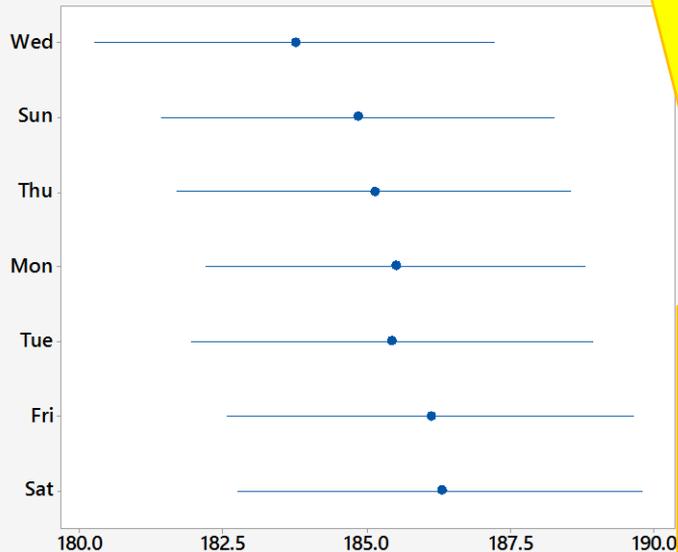


Differences among the means are not significant ($p > 0.05$).

Which means differ?
Differs from

#	Sample	Differs from
1	Wed	
2	Sun	
3	Thu	
4	Mon	None Identified
5	Tue	
6	Fri	
7	Sat	

Means Comparison Chart
Blue indicates there are no significant differences.

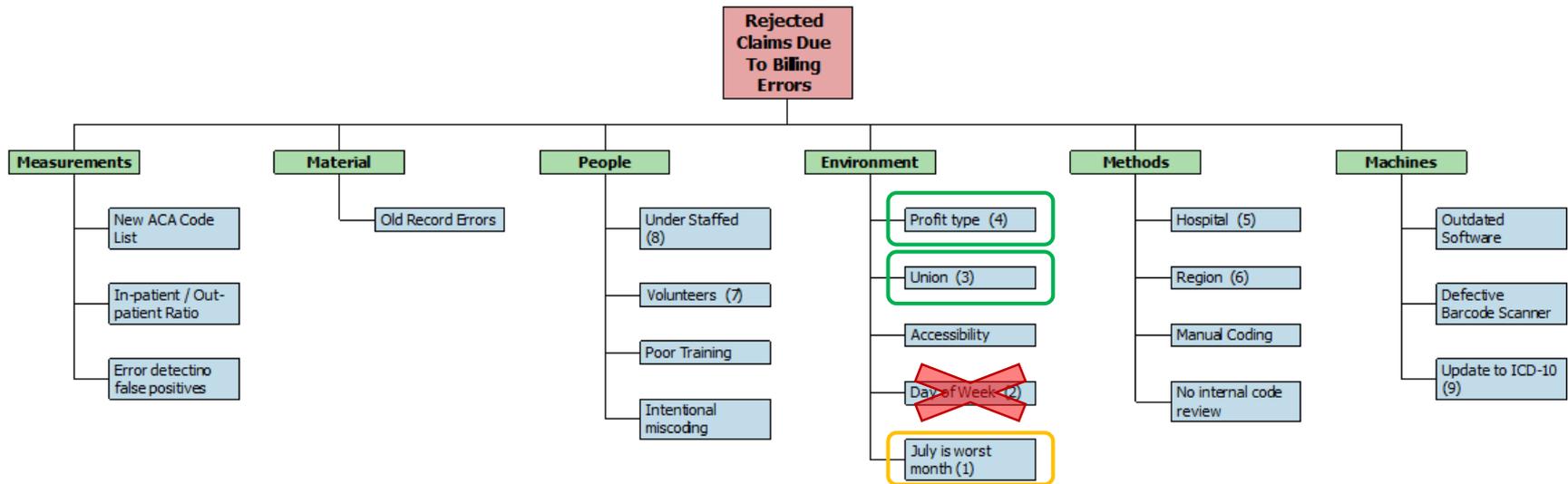


Comments

- Test: There is not enough evidence to conclude that there are differences among the means at the 0.05 level of significance.
- Comparison Chart: Blue intervals indicate that the means do not differ significantly.

Based on this study, there is no statistically significant difference in the mean value of rejected claims regardless of week day.

Possible Causes



- ✓ Since our initial test did not indicate a statistically significant difference between claims rejected based on the week day, it can be eliminated from further study. For now...
- ✓ Continue testing possible causes with more than 2 conditions using ANOVA.

ANOVA can test more than 2 groups!

ANOVA Test



One-Way ANOVA for Value by Month Summary Report

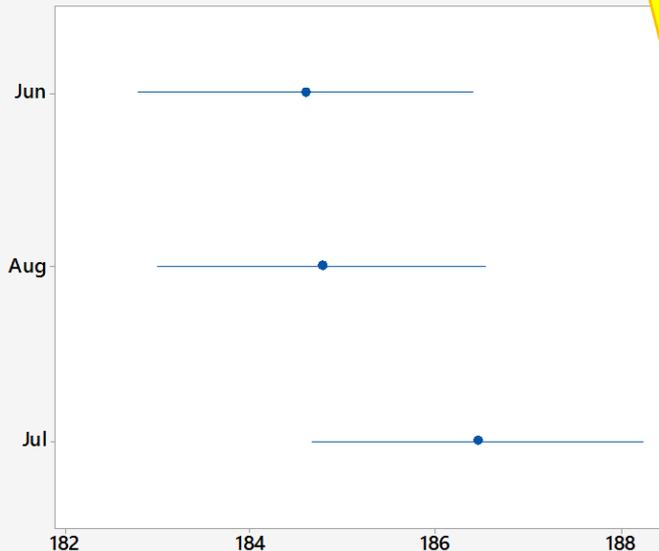
Do the means differ?



Differences among the means are not significant ($p > 0.05$).

Means Comparison Chart

Blue indicates there are no significant differences.



Which means differ?
Differs from

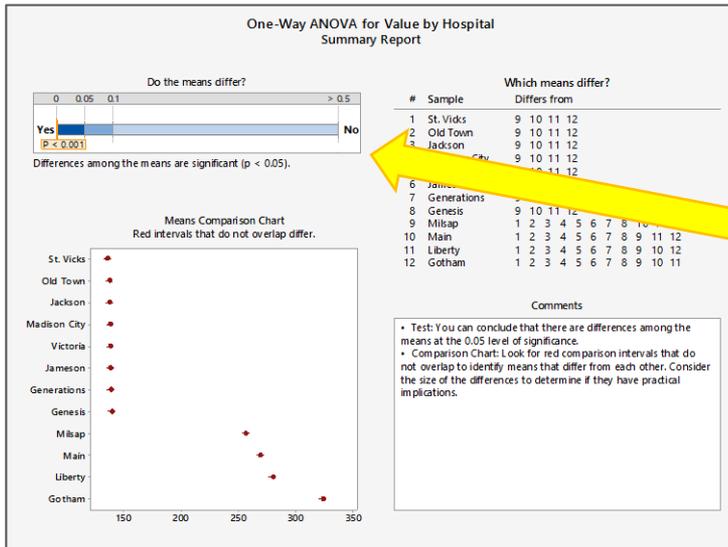
#	Sample	Differs from
1	Jun	
2	Aug	None Identified
3	Jul	

Comments

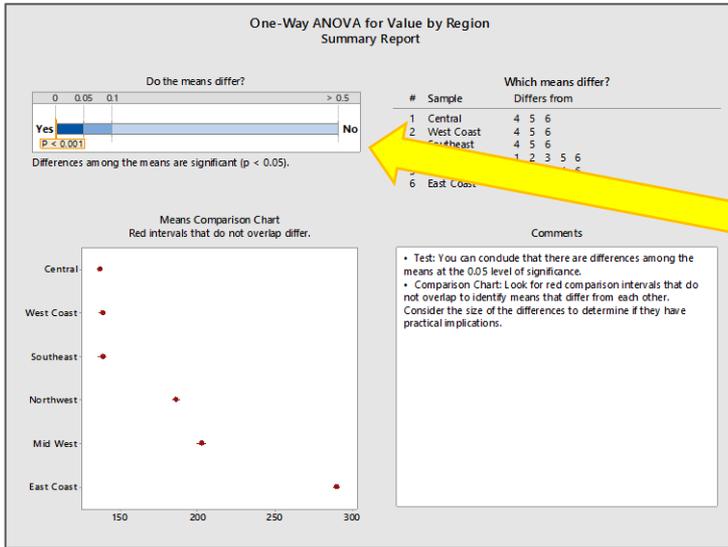
- Test: There is not enough evidence to conclude that there are differences among the means at the 0.05 level of significance.
- Comparison Chart: Blue intervals indicate that the means do not differ significantly.

Based on this study, there is no statistically significant difference in the mean value of rejected claims regardless of month.

More ANOVA Tests

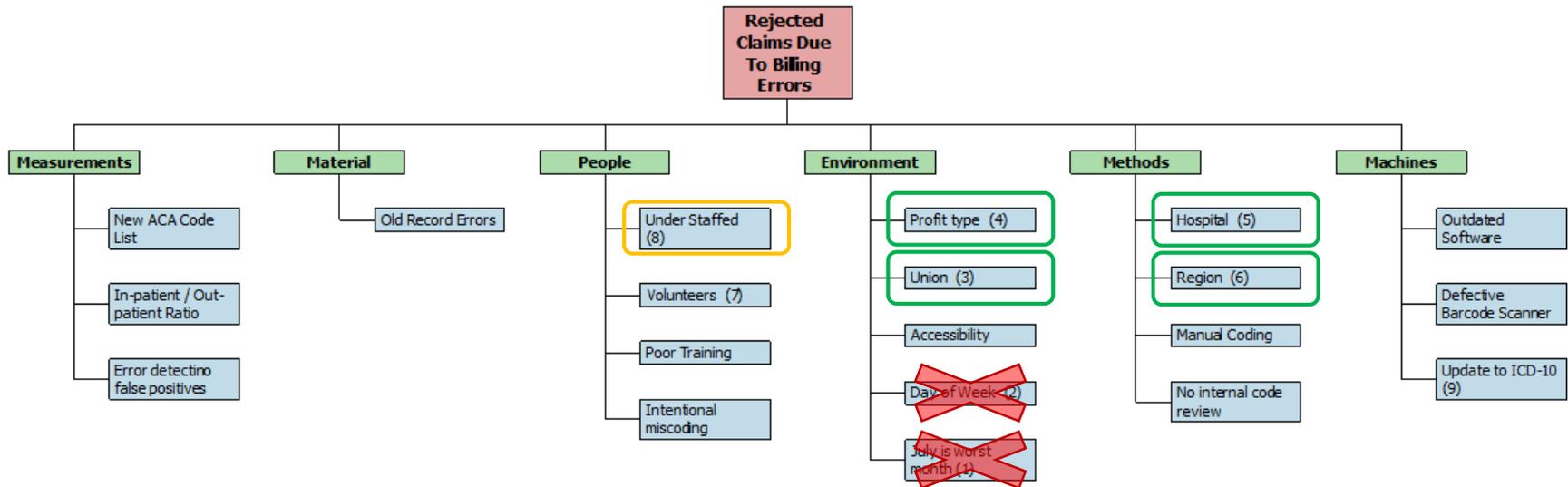


Based on this study, there is a statistically significant difference in the mean value of rejected claims from one or more hospital compared to other hospitals.



Based on this study, there is a statistically significant difference in the mean value of rejected claims from one or more regions compared to other regions.

Possible Causes

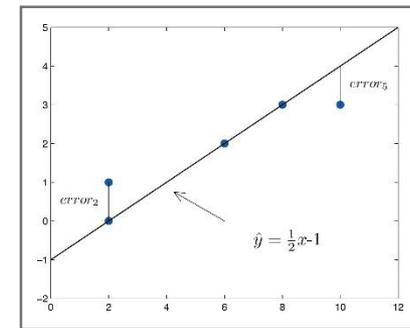
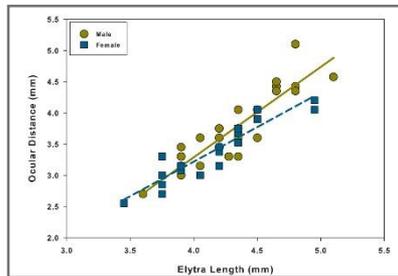


- ✓ Month is also eliminated...
- ✓ We would use the ANOVA Test to either eliminate or confirm the importance of each possible cause that has more than 2 possible conditions (Weekday; Month; Hospital; Region; etc.)
- ✓ But what about other possible causes that do not have discrete conditions, but are variable?
 - ✓ Staffing to Patient Ratio

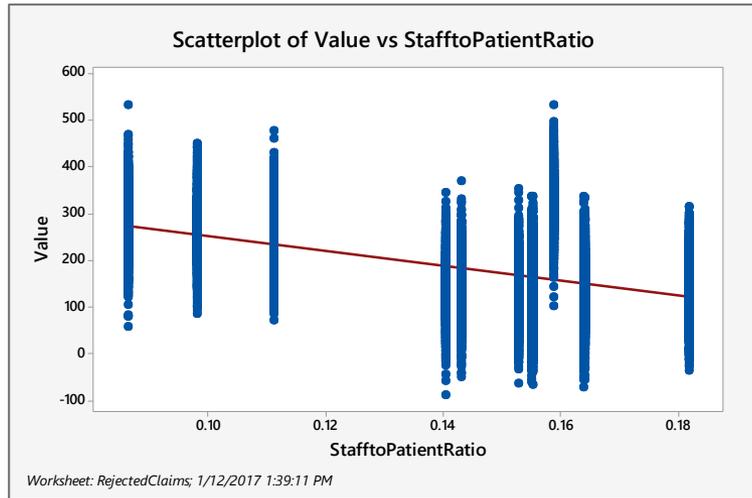
Let's check for any relationships!

Correlation – Regression

- ✓ Correlation analysis is used to quantify the degree of linear association between continuous variables.
- ✓ **Correlation DOES NOT imply causation!**
- ✓ Regression analysis is used to create an equation that defines the functional relationship between one or more continuous y's and at least one continuous x.



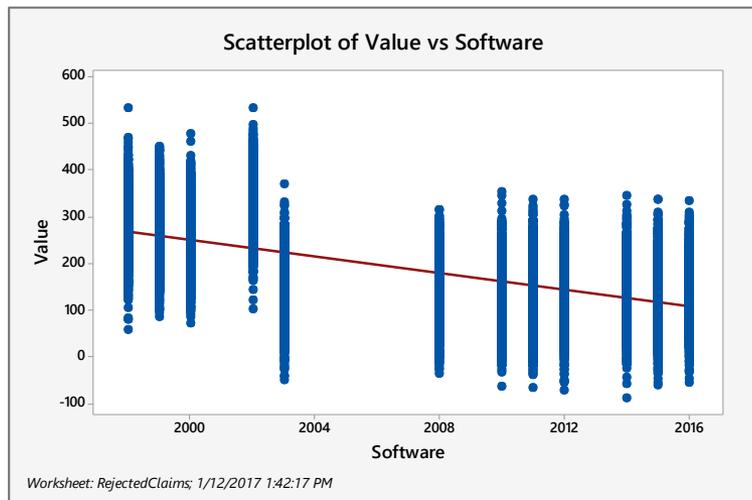
Correlation Study



Correlation: Value, StafftoPatientRatio

Pearson correlation of Value and StafftoPatientRatio = -0.479
P-Value = 0.000

Based on this study, there is a correlation between Staffing and Rejected Claim Value, but it is fairly weak. Additionally, correlation does not imply causation, so do not jump to conclusions yet!

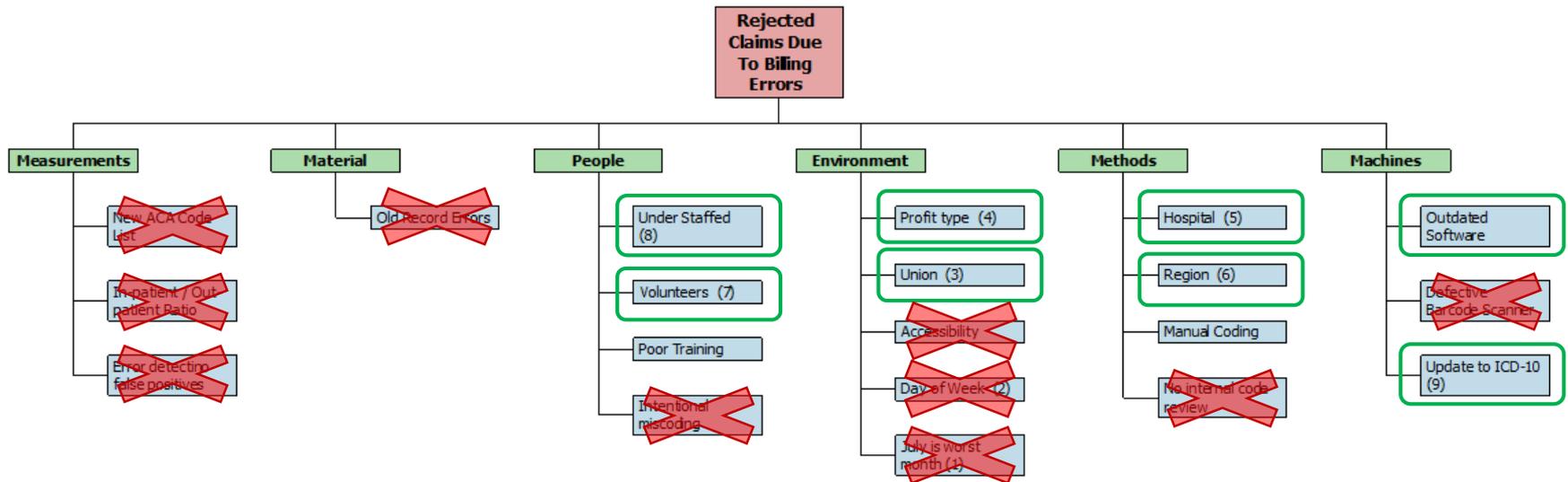


Correlation: Value, Software

Pearson correlation of Value and Software = -0.616
P-Value = 0.000

Based on this study, there is a correlation between Software Version and Rejected Claim Value, but it too is fairly weak. Recall, correlation does not imply causation, so do not jump to conclusions yet!

Possible Causes



- ✓ The team has tested or investigated most of the possible causes that resulted from the earlier Brainstorming Activity.
- ✓ Many were eliminated.
- ✓ Eight were confirmed or inconclusive (so leave them in)
- ✓ Two could not be tested due to lack of data.
 - ✓ New measurement system may be required.

Let's look at the Regression model!

Regression

- 
- ✓ Regression transitions from descriptive to inferential statistics.
 - ✓ Regression provides a mathematical model (formula) of a process, $Y = f(x)$.
 - ✓ Regressions can be relatively simple cases with one continuous input variable and an output.
 - ✓ Regressions can also be more complex with multiple (continuous or discrete) input variables and an output.

Regression

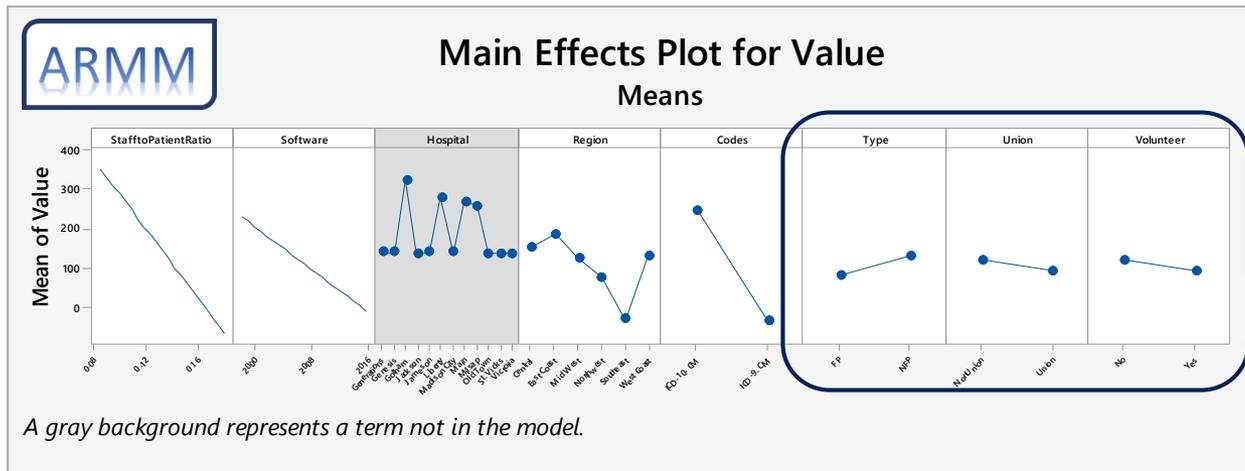
Regression Analysis results in a lot of information including:

S	R-sq	R-sq(adj)	R-sq(pred)
59.4112	57.54%	57.52%	57.49%

R-sq indicates that about 57.5% of the observed variation can be explained by the current model. This is not necessarily conclusive, but understanding some variation is better than understanding none.

Value = 27399 - 4354 StafftoPatientRatio - 13.192 Software
 0.0 Region_Central + 32.97 Region_East Coast - 27.70 Region_Mid West -
 78.29 Region_Northwest - 185.26 Region_Southeast - 25.42 Region_West Coast
 + 0.0 Codes_ICD-10-CM - 278.53 Codes_ICD-9-CM + 0.0 Type_FP + 48.19 Type_NFP
 0.0 Union_NonUnion - 29.06 Union_Union + 0.0 Volunteer_No - 25.75 Volunteer_Yes

Regression also constructs a formula that can be used to predict the output based on input data.



- Main Effects Plots show how much each factor contributes to the process variation.
- The larger the range, the higher the effect.
- Nearly flat lines may be removed from the model, then re-run the regression.

Regression

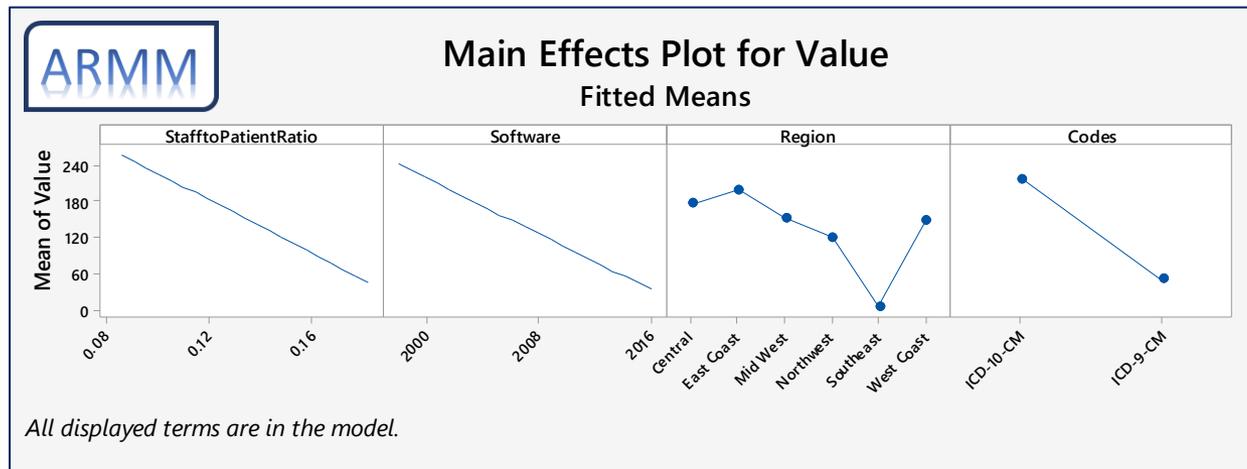
Regression Analysis results in a lot of information including:

S	R-sq	R-sq(adj)	R-sq(pred)
61.3746	54.68%	54.66%	54.64%

R-sq indicates that about 54.5% of the observed variation can be explained by the current model. This is lower than the initial study but the model is much more simple now.

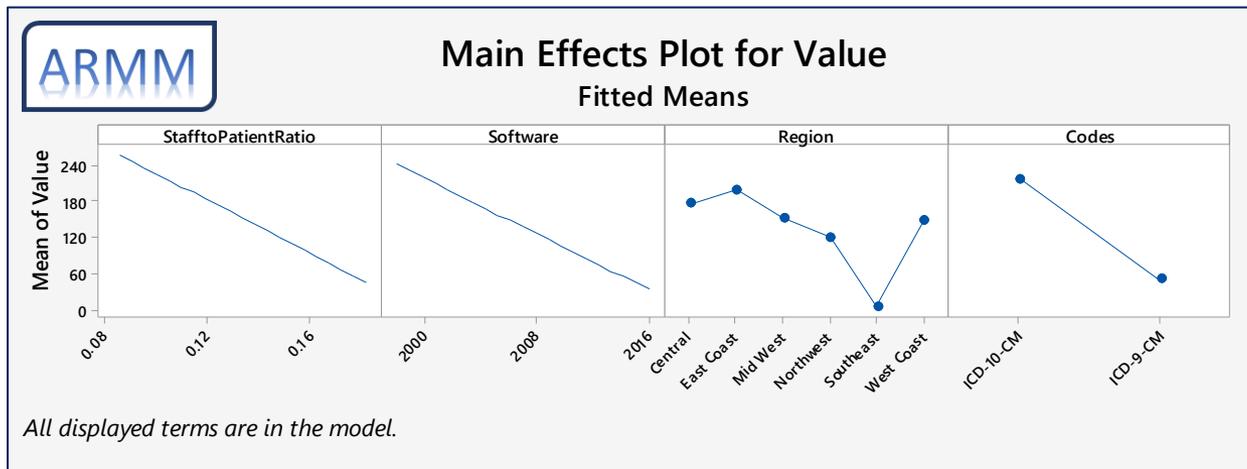
Region	Codes	Value
Central	ICD-10-CM	Value = 23883 - 2219.7 StafftoPatientRatio - 11.610 Software
Central	ICD-9-CM	Value = 23715 - 2219.7 StafftoPatientRatio - 11.610 Software
East Coast	ICD-10-CM	Value = 23905 - 2219.7 StafftoPatientRatio - 11.610 Software
East Coast	ICD-9-CM	Value = 23736 - 2219.7 StafftoPatientRatio - 11.610 Software
Mid West	ICD-10-CM	Value = 23859 - 2219.7 StafftoPatientRatio - 11.610 Software
Mid West	ICD-9-CM	Value = 23690 - 2219.7 StafftoPatientRatio - 11.610 Software
Northwest	ICD-10-CM	Value = 23827 - 2219.7 StafftoPatientRatio - 11.610 Software
Northwest	ICD-9-CM	Value = 23659 - 2219.7 StafftoPatientRatio - 11.610 Software
Southeast	ICD-10-CM	Value = 23710 - 2219.7 StafftoPatientRatio - 11.610 Software
Southeast	ICD-9-CM	Value = 23542 - 2219.7 StafftoPatientRatio - 11.610 Software

Multiple formulae based on Region and Codes but again, simplified.



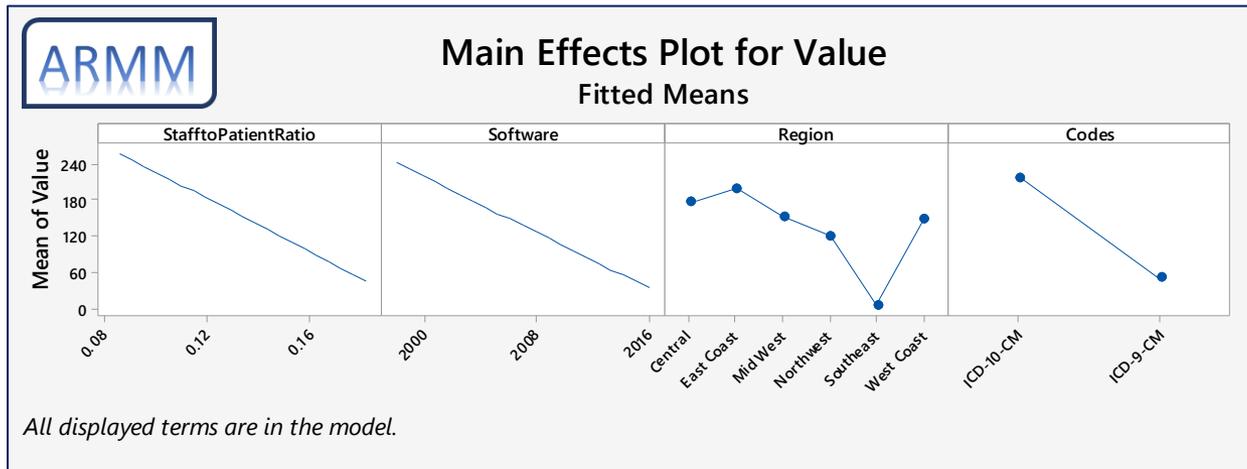
Based on this regression, we may suspect that, in order to minimize the rejected claims mean value, we need a higher staff to patient ratio, newer software, replicate the methods used in the Southeast region, and go back to ICD-9.

Regression



Based on this regression, we may suspect that, in order to minimize the rejected claims mean value, we need a higher staff to patient ratio, newer software, replicate the methods used in the Southeast region, and go back to ICD-9.

Regression

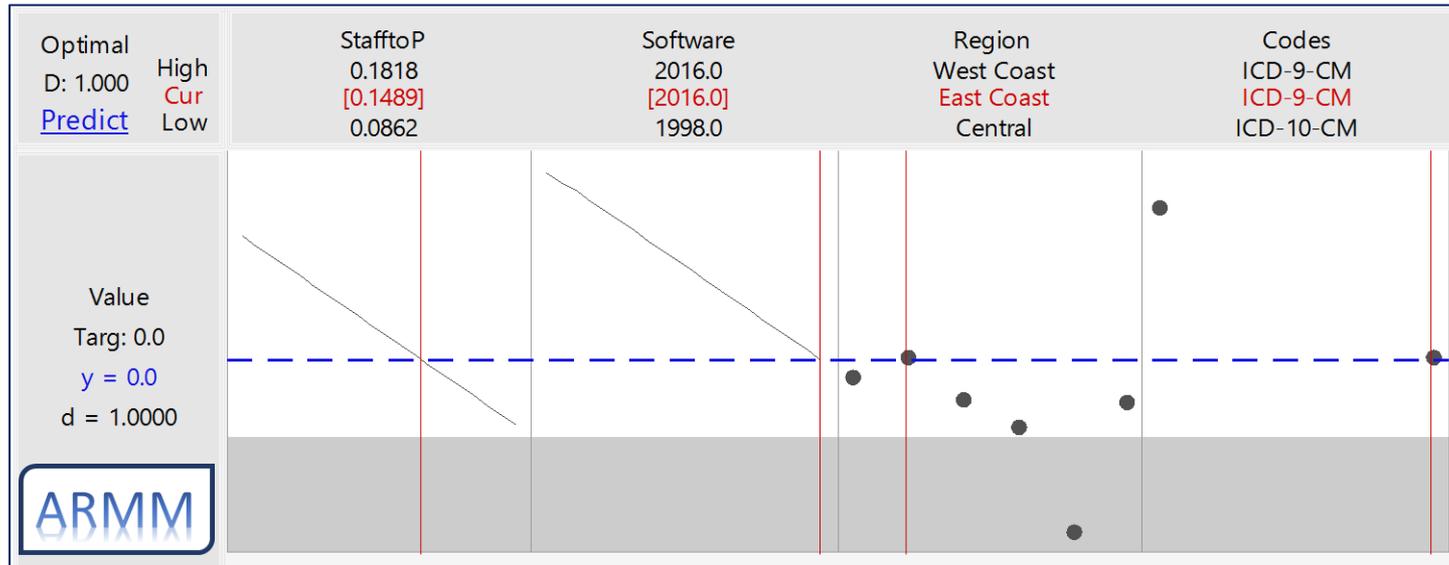


Based on this regression, we may suspect that, in order to minimize the rejected claims mean value, we need a higher staff to patient ratio, newer software, replicate the methods used in the Southeast region, and go back to ICD-9.

But those conditions may not be practical!

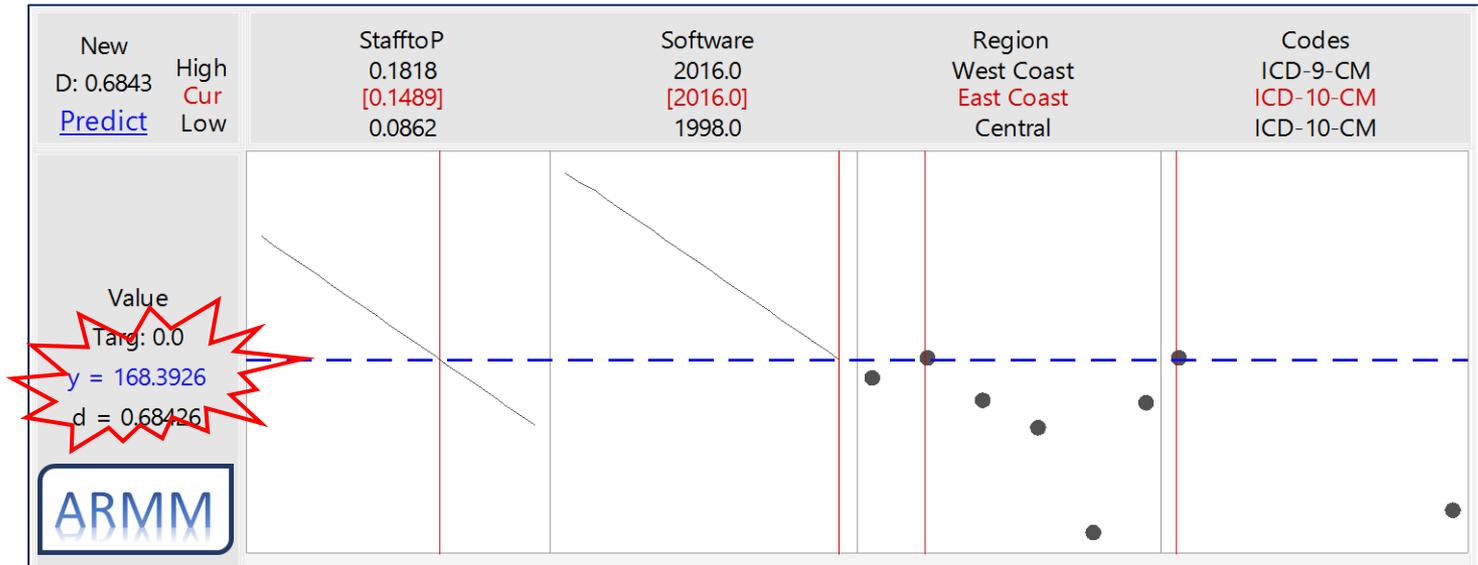
So let's use the Optimizer tool to look at possible scenarios that are more realistic.

Regression Optimizer



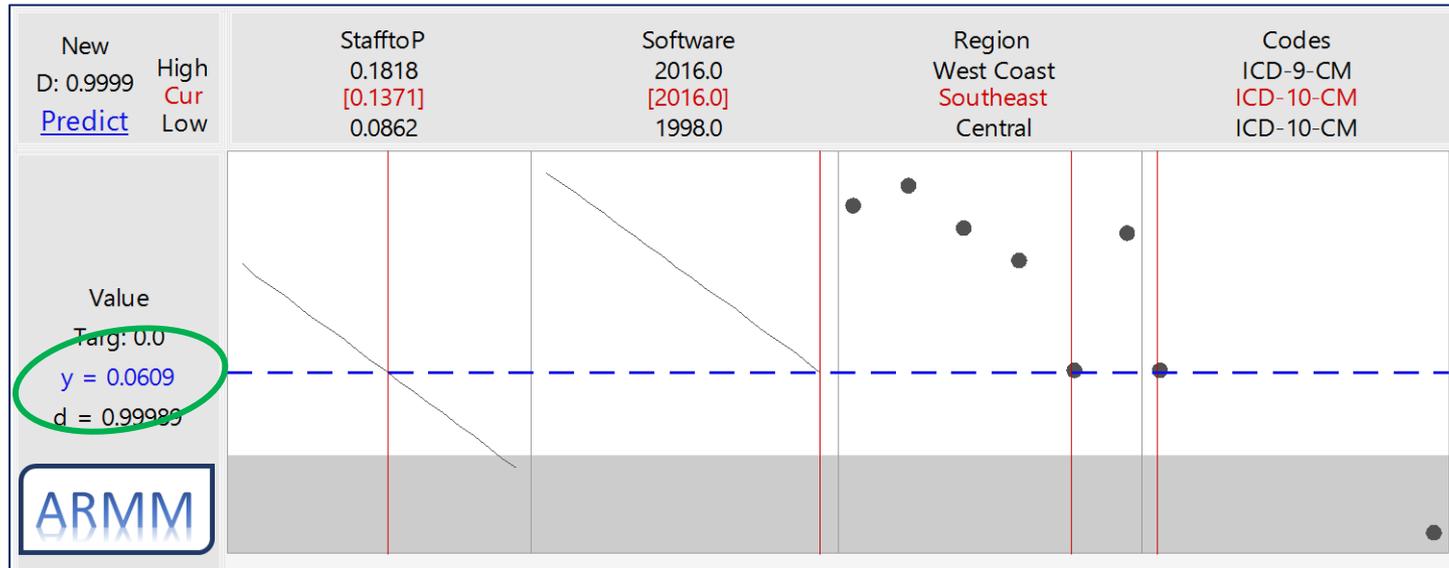
- The optimizer shows the best combination of factors to achieve the target that we asked for...in this case, \$0.
- But we can't go back to ICD-9...thankfully, the optimizer allows us to change settings and see a predicted result.

Regression Optimizer



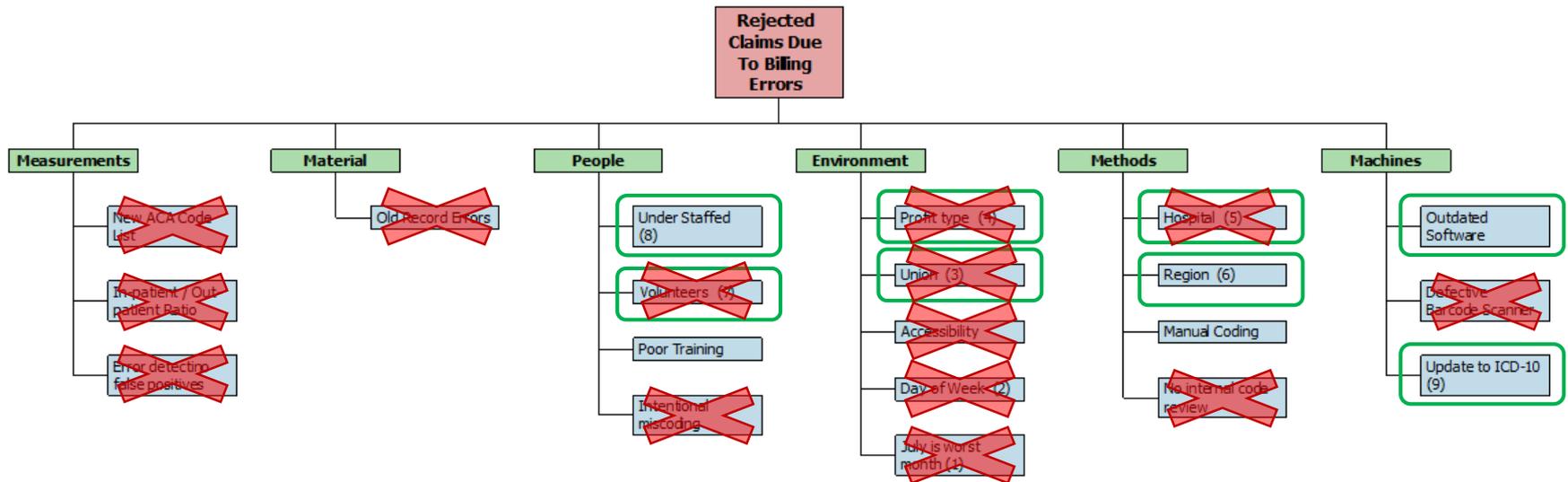
- Knowing that we cannot change from ICD-10, just grab the red line in the codes panel and move it.
- But now the model predicts a mean rejected claim value of \$168!
- Can we improve the prediction?

Regression Optimizer



- With ICD-10, replicating the practices of the Southeast Region, keeping the newest software, and staffing to a ratio of 0.1371, the model predicts the mean rejected claims value to be \$0.06.
- How do we make all this happen?

Possible Causes



- ✓ Based on the Regression, we eliminated 4 additional factors and are left with the Vital Few process factors / causes!
- ✓ Now on to the Improve Phase...

Other Situations



- ✓ All the tools presented are designed for datasets that fit the Standard Normal distribution (symmetrical, balanced)
- ✓ Many processes result in non-normal data (and that's ok!), non-parametric tests are available to analyze non-normal processes
- ✓ Often, we only have summarized data instead of raw data. In these cases, use proportions tests.

Define

Measure

Analyze

Improve

Control

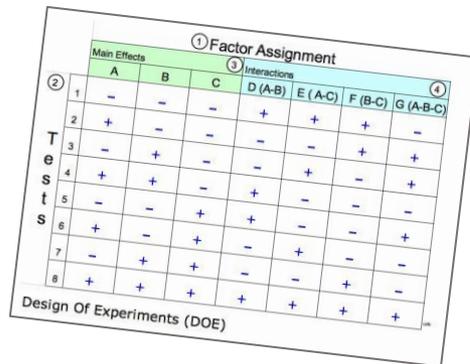


Improve

Implement and verify corrective actions using Pilot Trials and Designed Experiments (DOE).

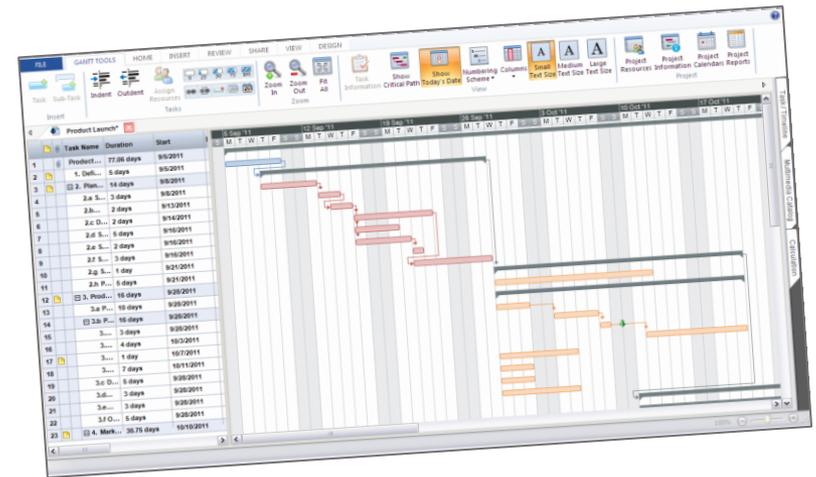
Improve

- ✓ Activity now becomes basic project management.
- ✓ Make a Plan – Execute the Plan – Evaluate the Results
- ✓ Additional tools may include using a Designed Experiment (DOE) to improve the Piloted process established in the Analyze phase.



Design Of Experiments (DOE)

		① Factor Assignment						
		Main Effects			Interactions			
		A	B	C	D (A-B)	E (A-C)	F (B-C)	G (A-B-C)
② T E S T S	1	-	-	-	+	+	+	-
	2	+	-	-	-	-	-	+
	3	-	+	-	-	-	+	-
	4	+	+	-	-	+	-	+
	5	-	-	+	+	-	-	-
	6	+	-	+	+	-	-	+
	7	-	+	+	-	+	-	-
	8	+	+	+	+	+	+	+



Making the Changes

- An Action Item List is a common tool that aids teams in completion of tasks and follow up / follow through.

Action Item Register									
Project:	Reduce Mean Rejected Claim Amount			Date	9/15/2015				ARMM
	Action Item	Owner	Due Date	Progress				Comments	
1	Team travel to all Southeast Region hospitals to understand and document their practices and procedures.	Lidio (LSSBB)	10/1/2015		50%	75%	100%	Travel plans scheduled.	
2	Document practice / procedural differences across organization.	Team	12/1/2015	25%	50%	75%	100%		
3	Develop strategy to standardize practices / procedures across the organization.	Mindy (CFO)	1/15/2016	25%	50%	75%	100%		
4	Update and go live all hospitals to newest software version.	Info. Systems	1/15/2016	25%	50%	75%	100%		
5	Train all hospitals on new software version.	Info. Systems	1/15/2016	25%	50%	75%	100%		
6	Complete organization-wide assessment of Staff to Patient Ratio.	Dave (HR VP)	10/1/2015	25%	50%	75%	100%		
7	Develop strategy to staff to optimized rate in East Coast Region to pilot the higher staffing level.	Dave (HR VP)	11/1/2015	25%	50%	75%	100%	Pilot plan to be developed not to exceed 90 days.	
8	Develop staffing level Pilot Plan	Dave (HR VP)	11/15/15	25%	50%	75%	100%		

Define

Measure

Analyze

Improve

Control



Control

Establish and control your new process and monitor it over time to hold the gains with SPC or other tools.

Control

✓ Control Phase includes developing:

✓ Control Plans

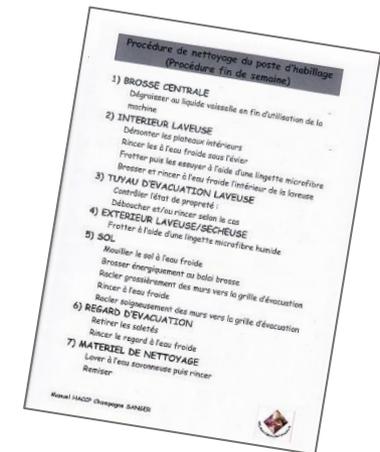
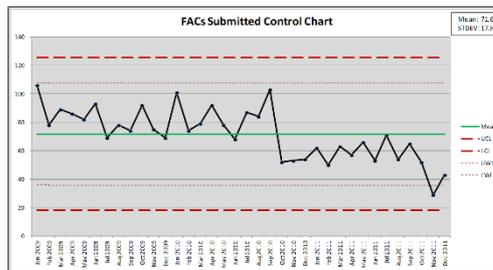
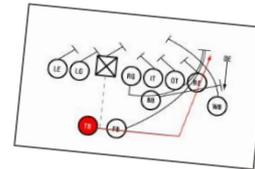
✓ Procedures

✓ Play Books

✓ Training For Everyone

✓ Control Charts

Control Plan										
Project Type	Project Cat. Code	Process Name	Process Category	DATE CREATED	DATE REVISED					
	QC Number	Process Owner Name	Unit	Process Number	Process Owner Approval Date					
	Project Champion Name	Measurement System Control	Plan	Process Number	Project Champion Approval Date					
	Project Lead Name	Control Plan Control	Plan	Process Number	QSP Project Check Approval Date					
Process Step	Process Step Input (X)	Process Step Output (Y)	Process Step Output (Y)	PROCESS PERFORMANCE CHARACTERISTICS			CONTROL METHOD			REACTION PLAN (Refer to Process Map)
				UCL	SL	Target	Control Sigs	Out of Control Conditions	Measurements taken for Control	



Summary



DMAIC problem solving includes:

- Defining the problem
- Assessing the measurement systems
- Collecting data
- Identifying possible causes
- Using statistical tools to evaluate possible causes
- Finding the Vital Few causes (factors)
- Implementing process changes
- Optimizing the new process
- Controlling the new process to maintain the gains

Define

Measure

Analyze

Improve

Control

Define

Measure

Analyze

Improve

Control



What questions do you
have for me ?

Define

Measure

Analyze

Improve

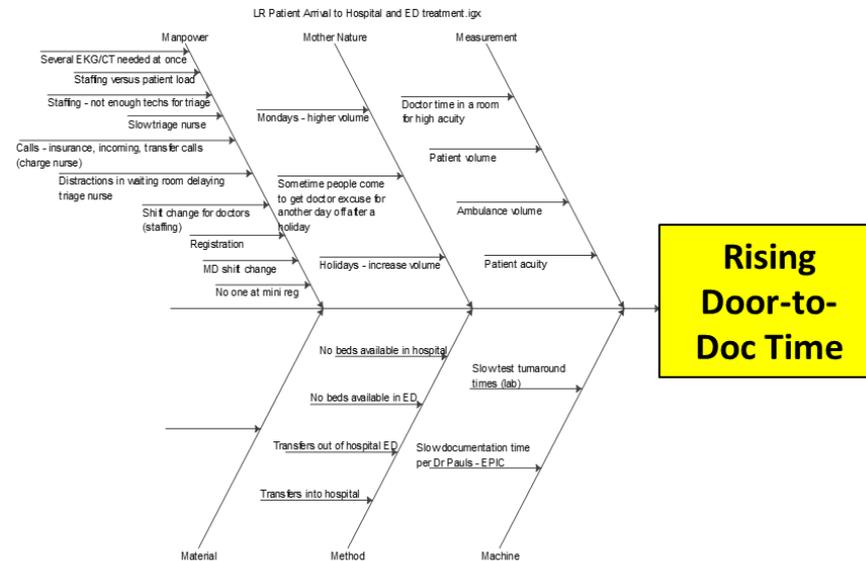
Control



Appendix

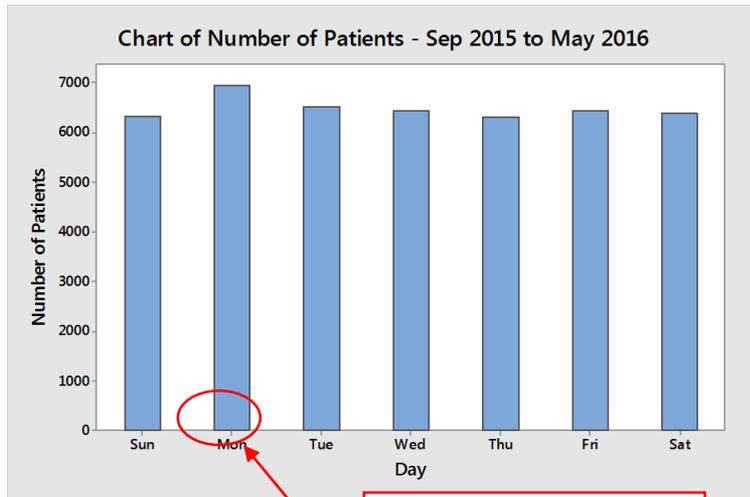
Real Example

- Prolonged wait times to be triaged
- LWBS (2015): 4.61%
- Avg 10 /day for April
- Not a clear understanding of Arrival-to-Doc time
- LOS (2015): 201.6

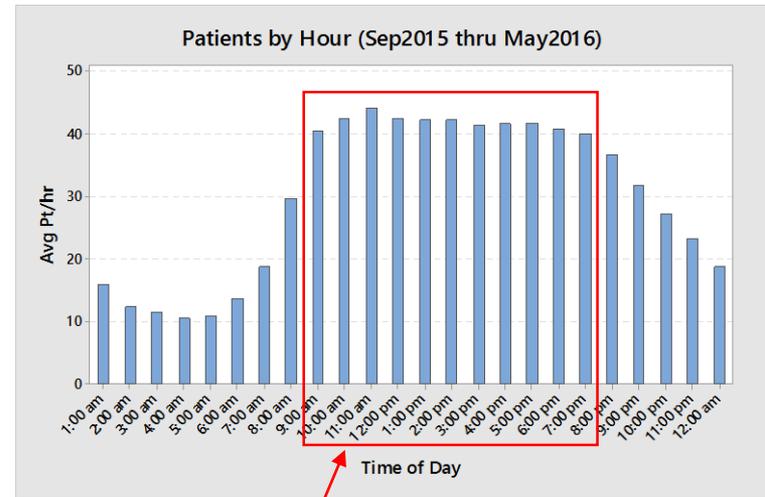


Real Example

Patient Arrival by Day and Hour

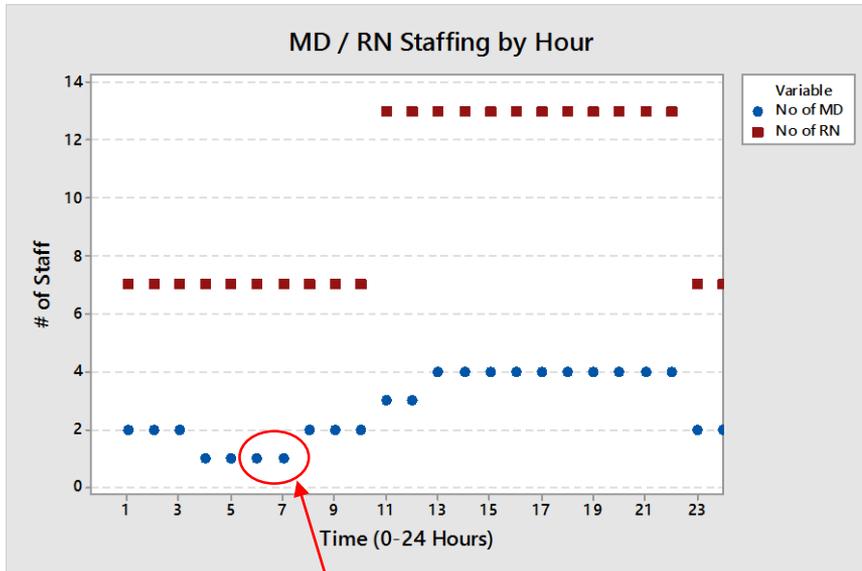


Monday is the highest volume day of the week

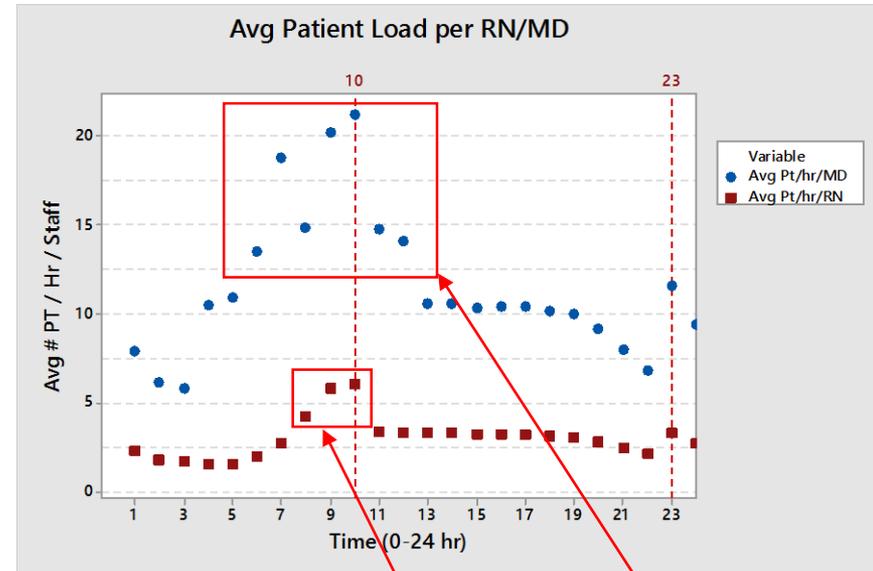


9am – 7pm are the highest volume hours of the day

Real Example



1 MD at 6am-7am



Patient-RN ratio is above 3.5 from 8am-10am

Patient-MD Ratio is above 12 from 6am-12pm

Real Example Results

