For Microsoft ® Windows ®

Microsoft Excel ® Add-in

June 2010

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1. Getting Started

Overview

This user manual introduces you to the basic features in ProcessMA. The following chapters briefly explain the use of the key analysis tools and steps to perform analysis in different situations:

- Statistical Analysis
- Graphical Analysis
- Regression
- Measurement System Analysis
- Capability Analysis
- Design of Experiments
- Statistical Process Control
- Reliability and Survival
- Quality Tools
- ProcessMA Interactive

Starting ProcessMA

At the Windows Taskbar, choose **Start > Programs > ProcessMA > ProcessMA**. Microsoft Excel will be launched automatically together with ProcessMA.

If you want ProcessMA to start whenever you launch Excel, go to the folder where ProcessMA was installed (default: C:\Program Files\ProcessMA), make a copy of **ProcessMA.xla** into **C:\Program Files\Microsoft Office\OfficeXX\STARTUP**.

Workbook and Worksheet

ProcessMA will operate in any workbooks you create in Excel. In each workbook, you can create any number of worksheets to organise your project information and store your data. The data must be arranged in columns also called variables with the first row as the column/variable name. During analysis, ProcessMA will read all the data columns in the same worksheet and output the analysis results in a single new worksheet.

You can also make use of the **Worksheet Manager** tool to help you to organise and locate worksheets easily.

Getting Help

If you need assistance in completing a dialog box for any tools, click on the **Help** button located at the bottom left of the dialog box. Each Help file will provide an overview of the tool, instructions on how to complete the dialog box, the type of data required and complete with an example to illustrate what the tool can do for you.

You can also access the help file by choosing **ProcessMA > Tools < Help** from the Excel menu bar.

Tool Selector

The tool selector can help you to select the appropriate tool in ProcessMA based on your objective and data type. You can select the tool by Six Sigma DMAIC phases or by functional categories. Start the tool selector by choosing **ProcessMA > Tools > Tools Selector > By DMAIC or By Function.**

2. Statistical Analysis

The following are the tools you can use in ProcessMA to perform statistical analysis based on different situations:

Descriptive Statistics

Displays descriptive statistics for a given set of data including mean, standard deviation, percentiles, confidence intervals

Basic Statistics

1 Sample Z - hypothesis test of the mean based on sampled data when the population standard deviation, σ is known. It also calculates a confidence interval of the mean. This procedure is based on normal distribution. For larger samples (>30), the sample standard deviation may be used in the absence of the population standard deviation. For smaller samples, make sure the data is drawn from a normal distribution or the t-test may be more appropriate

1-Sample t - hypothesis test of the mean based on sampled data when the population standard deviation, σ is unknown. It also calculates a confidence interval of the mean. This procedure is based on the t-distribution which is derived from a normal distribution. It is more conservative than the Z-test for smaller sample sizes or when s is unknown.

2 Sample t - hypothesis test of the difference between two population means when the population standard deviation, σ is unknown. It also calculates a confidence interval of the mean. This procedure is based on the t-distribution which is derived from a normal distribution. The samples should be drawn independently from each other. For dependent samples, use the Paired t-test.

Paired t - hypothesis test of the difference between two population means when observations are paired. It also calculates a confidence interval of the difference. This procedure is based on the t-distribution which is derived from a normal distribution. It is appropriate when the paired differences follow a normal distribution. If the observations are dependent in a pairwise manner, the matching results in smaller variance and greater power of detecting differences than the 2-sample t.

1 Proportion - hypothesis test and calculates a confidence interval of the population proportion. It is a test of one binomial proportion.

2 Proportions - hypothesis test of the difference between two proportions and calculates a confidence interval.

Chi-square and Contingency Tables - tests if there is association between the classification of one variable and the classification of another variable

Chi-Square Goodness-of-Fit Test - tests if the data follows a multi-nominal distribution with certain proportions.

Correlation - calculates the Pearson product moment correlation coefficients for each pair of variables. It can be used to test if variables are correlated.

Covariance - calculates the covariance for each pair of variables. Like the correlation coefficient, it can be used to test if variables are correlated.

ANOVA

One-way ANOVA - is like an extension of the two-sample t-test. It is use to compare the equality of more than two means.

Two-Way ANOVA - tests the equality of means of populations classified by two factors. It requires the data to be balanced (all factor combinations must have the same number of observations).

Fully Nested ANOVA - performs a fully nested analysis of variance and estimates the variance components for the response variable.

General Linear Model - perform univariate analysis of variance with balanced and unbalanced designs and regression for the response variable.

Analysis of Means - generates a Analysis of Means chart for normal, binomial or Poisson data.

Test of Equal Variance - conducts hypothesis tests for the equality variances using F, Bartlett's and Levene's tests. The F Test is performed in place of the Bartlett's test when there are only two levels. Many statistical procedures like ANOVA and 2-Sample t-test assumes that samples are taken from populations with equal variances. This procedure can be used to valid this assumption.

Nonparametric Analysis

Nonparametric tests do not make assumptions that the population is from a specific distribution. Therefore its results are more robust than a parametric test when such assumptions are violated.

1 Sample Sign - nonparametric test of population location (median) and also calculate the corresponding point estimate and confidence interval. Its parametric counterpart is the 1-sample Z and 1-sample t tests.

1 Sample Wilcoxon - nonparametric test of the population location (median) and it also calculates the corresponding point estimate and confidence interval. It assumes that the data are a random sample from a continuous and symmetric population. Its parametric counterpart is the 1-sample Z and 1-sample t-tests.

2 Sample Mann-Whitney - (also known as two-sample Wilcoxon rank sum test) is a nonparametric test of the equality of two population medians. It also calculates the corresponding point estimate and confidence interval. Its parametric counterpart is the Paired t test.

Kruskal-Wallis - nonparametric test of the equality of medians for two or more populations. Its parametric counterpart is the One-Way Analysis of Variance. This procedure assumes that the samples are randomly and independently drawn from populations that have the same shape. It is more robust than the Mood's median test for data of many distributions but is less robust for data with outliers.

Mood's Median Test – nonparametric test of the equality of medians for two or more populations. Its parametric counterpart is the One-Way Analysis of Variance. This procedure assumes that the samples are randomly and independently drawn from populations that have the same shape. It is more robust than the Kruskal-Wallis for data with outliers and is appropriate for preliminary stages of analysis.

Friedman - nonparametric analysis of a randomised block experiment. Its parametric counterpart is the Two-Way Analysis of Variance. It requires the data to be balanced (all factor combinations must have the same number of observations).

Power and Sample Size

The Power and Sample Size tools calculate power, sample size and minimum difference for 1 Sample Z, 1 Sample t, 2 Sample t, Paired t, 1 Proportion, 2 Proportions, One-way ANOVA.

Example: One-Way ANOVA

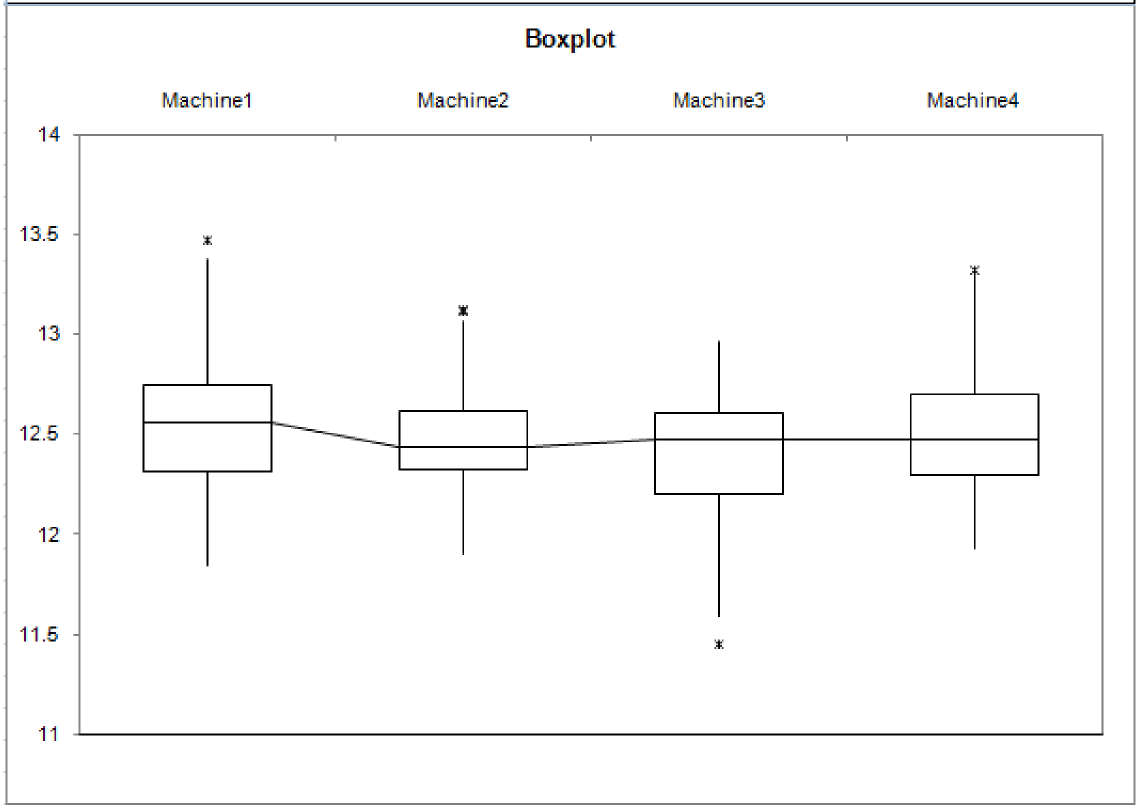
A company makes steel bolts using four different machines. You want to assess if the dimensions of the steel bolts made are the same for the different machines. You randomly selected 50 steel bolts made by each machine.

Steps

1. Open data worksheet by choosing ProcessMA > Tools > Data
2. Choose ProcessMA > Statistics > ANOVA > One-Way ANOVA
3. In Variable, select B - Dimension
4. In Subgroup, select C - Machine
5. Check Show Boxplot
6. Click OK

Results

One-Way ANOVA					
Source	DoF	SS	MS	F	P Value
Factor	3	0.3379	0.1126	1.2114	0.3068
Error	196	18.2238	0.0930		
Total	199	18.5617			
Pooled Std Dev	0.3049				
R-sq	1.82%				
R-sq(adj)	0.32%				
Level	N	Mean	Std Dev	95% CI - Lower	95% CI - Upper
Machine1	50	12.5264	0.3449	12.4414	12.6114
Machine2	50	12.4850	0.2730	12.4000	12.5700
Machine3	50	12.4156	0.2861	12.3306	12.5006
Machine4	50	12.5012	0.3108	12.4162	12.5862



Interpretation

For a desired a = 0.05, since p = 0.3068> a, we fail to reject H0. Therefore, we conclude that there is no significant evidence that the dimensions of the steel bolts made by the different machines are different. It can also be observed from the individual confidence intervals that there are significant overlaps. The residual plots should also be examined to ensure that the residuals are normally distributed, centered about zero and random.

3. Graphical Analysis

ProcessMA provides a wide range of graphical tools to help you visualize a large amount of data in a single plot.

Run Chart - plots individual observations in run order. It can also perform tests for trends, oscillation, mixtures and clustering (special causes or non-random behaviors).

Pareto Chart - a type of bar charts where bars are categories and the height of the bar represents its frequency. The bars are sequenced in descending order and there is also a cumulative percentage line that indicates the added contribution of each category to the total. The Pareto Chart is usually used to identify the 'vital few' from the 'trivial many'. For example, if categories are different types of defects, it helps you identify the most frequently occurring defect to help you focus improvement efforts.

Multi-Vari Chart - used to display ANOVA data. This procedure can plot up to 4 factors.

Histogram - a type of bar charts where bars are intervals of continuous data and the height of the bars represent the frequency for that interval. The Histogram can be used to visualise the distribution of the data.

Pie Chart - visualise the contribution of various categories to the whole

Time Series Plot - plots observations in the order of time.

Scatter Plot - plots observations based on its x and y coordinates

Dotplot - similar to the histogram but frequency is represented by the number of dots. A dot represents one observation or a group of observations if they are of the same or about the same value. The Dotplot is useful for comparing distributions

Boxplot - (also called the box-and-whisker plot) represents the distribution of data as a box and whiskers. It is useful for comparing the distribution of various groups of data.

Matrix Plot - made up of individual scatter plots for several variables. It is useful for visualising the relationship among many variables, pairwise, all in the same chart.

Probability Plot - display a probability plot for variables.

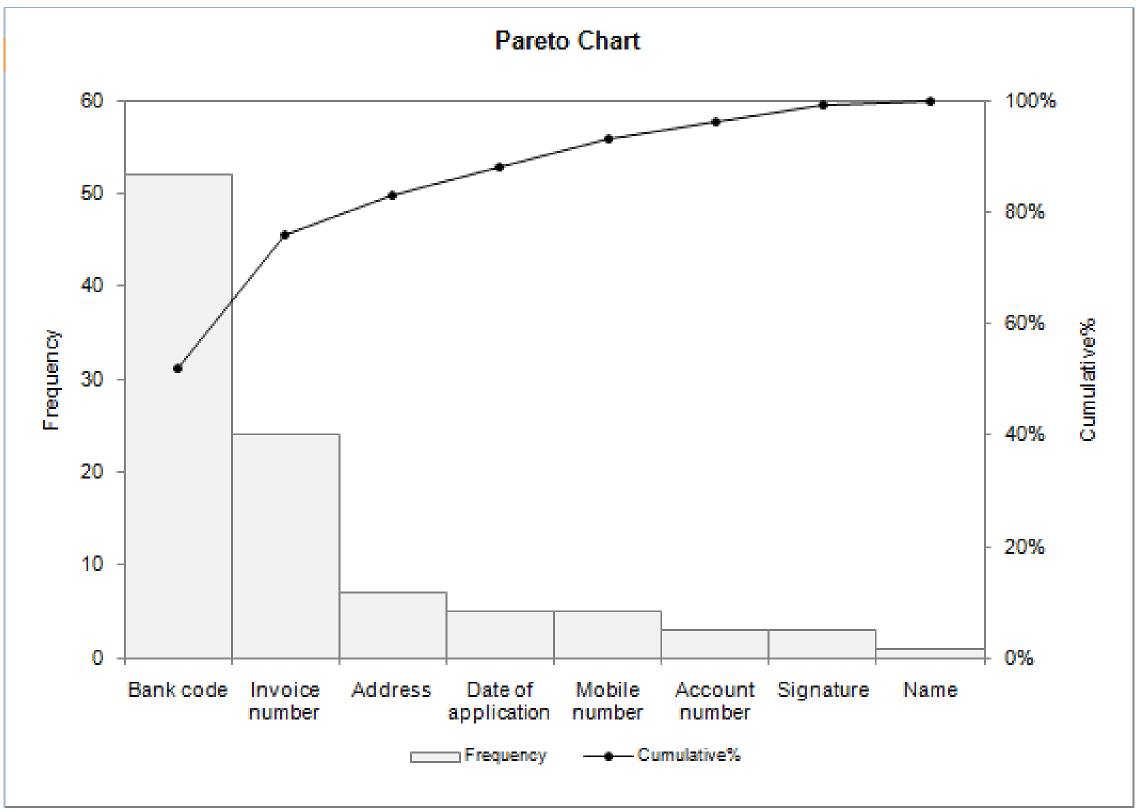
Example: Pareto Chart

You found out that one of the reasons for processing delays is due to incomplete application forms. You collected data on the type of information missing in the application forms received for the past 2 weeks. You want to use the Pareto Chart to identify the types of information that are most frequently missing.

Steps

1. Open data worksheet by choosing ProcessMA > Tools > Data
2. Choose ProcessMA > Graphs > Pareto Chart
3. In Variable, select A - Missing
4. Click OK

Results



Interpretation

Since 76% of the missing information in application forms are ‘bank code’ and ‘invoice number’, you may want to focus improvement efforts on resolving these two issues first.

4. Regression

Regression can be used to determine and quantify relationships between variables.

Regression (Single Predictor) - performs regression with a single predictor, in linear, second-order or third-order polynomial terms

Regression (Multiple Predictors) - performs regression with multiple predictors using the least squares method

Logistic Regression (Binary) - perform logistic regression for binary response variable with one or more predictors.

Logistic Regression (Ordinal) - perform logistic regression for ordinal response variable with one or more predictors. Ordinal variables are variables with 3 or more levels and these levels have a natural ordering.

Logistic Regression (Nominal) - perform logistic regression for nominal response variable with one or more predictors. Ordinal variables are variables with 3 or more levels and these levels have no natural ordering

Example: Regression (Multiple Predictors)

You know that sales revenue is dependent on the number of sales representative on the field, the amount spend on marketing and the range of products offered. You gathered data from 30 branches and you want to model the relationship and also predict the sales for the new branch.

Steps

1. Open data worksheet by choosing ProcessMA > Tools > Data
2. Choose ProcessMA > Statistics > Regression > Regression (Multiple Predictors)
3. In Response, select G - Sales
4. In Predictors, select H - Reps, I - Marketing, J - Products
5. Click OK

Results

Regression Analysis: Sales					
Regression Eqn	1054241.33 + 3997.768Reps + 0.656Marketing + 64943.905Products				
S	121248.6079				
R-Sq	0.7722				
R-Sq(adj)	0.7459				
Predictor	Coef	SECoef	T	P-Value	
Constant	1054241.33	89724.0775	11.75	0	
Reps	3997.7683	1989.3045	2.01	0.055	
Marketing	0.656	4.0967	0.16	0.874	
Products	64943.9048	14674.462	4.426	0	
ANOVA					
Source	DoF	SS	MS	F	P Value
Regression	3	1.29551E+12	4.31838E+11	29.3743	0
Residual Error	26	3.82232E+11	14701224928		
Total	29	1.67774E+12			

Interpretation

The p values for number of representatives and product range is small, indicating that there is significant evidence that the coefficients of these predictors are not zero. The p value for amount spent on marketing is 0.874, indicating that there is no significant evidence that its coefficient is not zero. There, the amount spent on marketing will not contribute much to the prediction of sales revenue. You should also analyse and examine the residuals.

5. Measurement System Analysis

Gage Run Chart - plots the measurements by operator and by part, and a reference line at the overall mean. It is used to visualise measurement between different operators and parts.

Gage Linearity and Bias Study - determines the accuracy of your measurements through the expected measurement range. In other words, it can help you determine if your gage has the same accuracy when measuring objects of different sizes and if your gage is biased when compared to a master value.

Gage R&R – the Gage Repeatability and Reproducibility study helps you to determine how much of the observed process variation is due to measurement system variation

Attribute Gage Study - examines the precision of a measurement system when measurement is binary. It calculates the amount of bias and repeatability of the measurement system.

Attribute Agreement Analysis - assesses the accuracy of subjective ratings by people. In general, it is more likely that subjective ratings are accurate and useful if there is substantial agreement in measurements among appraisers

Example: Gage R&R

Three operators took measurements on 10 parts, twice on each part. You want to determine how much of the observed process variation is due to measurement system variation.

Steps

1. Open data worksheet by choosing ProcessMA > Tools > Data
2. Choose ProcessMA > Quality Tools > Gage R and R > Gage R and R
3. In Measurement, select AQ - Measurement
4. In Part, select AR - Part
5. In Operator, select AS - Operator
6. Click OK

Results

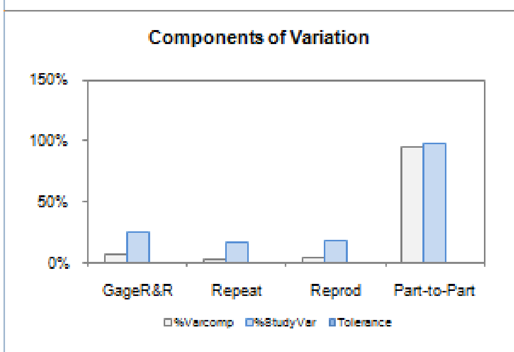
Gage R&R (Crossed)

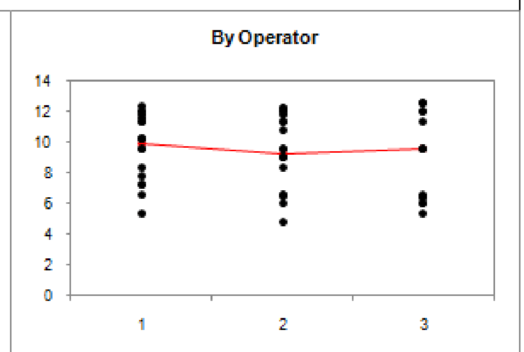
ANOVA

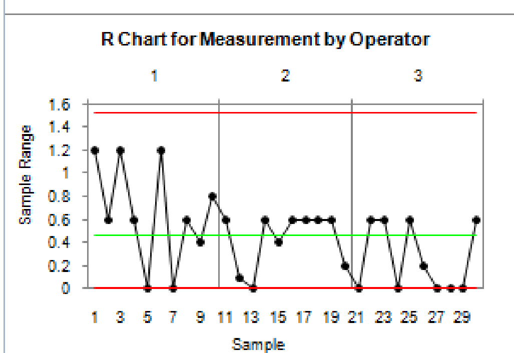
Source	DoF	SS	MS	F	P Value
Part	9	327.354	36.373	111.553	0
Operator	2	5.854	2.927	8.978	0.002
Operator*Part	18	5.869	0.326	1.947	0.052
Repeatability	30	5.025	0.168		
Total	59	344.102			

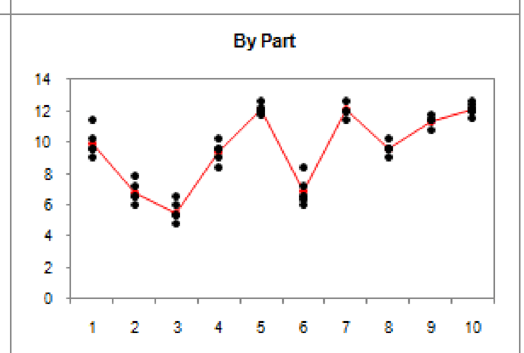
Source	Varcomp	%Varcomp	StdDev(SD)	StudyVar(6*SD)	%StudyVar
Total Gage R&R	0.3768	5.90%	0.614	3.683	24.3%
Repeatability	0.1675	2.62%	0.409	2.456	16.2%
Reproducibility	0.2093	3.28%	0.458	2.745	18.1%
Operator	0.1301	2.04%	0.361	2.164	14.3%
Operator*Part	0.0793	1.24%	0.282	1.689	11.1%
Part-to-Part	6.0078	94.10%	2.451	14.706	97.0%
Total Variation	6.3846	100.00%	2.527	15.161	100.0%

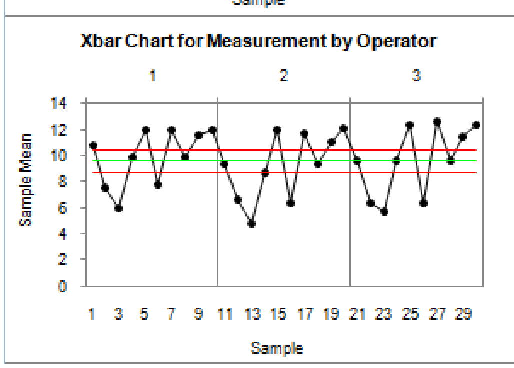
#Dist Category 5

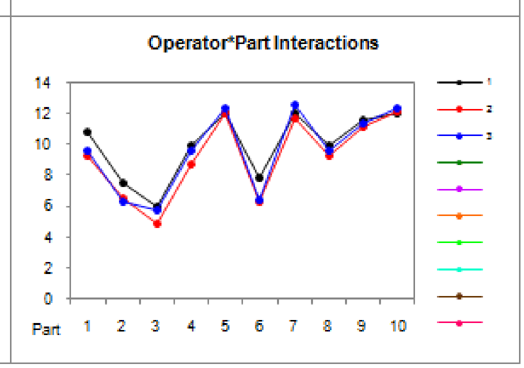












Interpretation

By looking at %VarComp, the variation due to differences between parts (Part-to-Part) contributes 94.1% to the overall variation. It is much larger than that of the Total Gage R&R at 5.9%. The same observation can be made by looking at the Component of Variation Chart. This indicates that measurement system error is small. From the By Part Chart, the variation of the red line shows that there are significant differences between parts. On the other hand, from the By Operator Chart, the red line is relatively flat, which indicates that the differences between operators are small. In addition, most of the points in the Xbar Chart for Measurement by Operator are out-of-control, indicating that variation is mainly due to differences between parts.

6. Capability Analysis

Capability Analysis generates a process capability report containing various capability indices. It usually also generates a histogram of the data with normal curves.

Capability Analysis (Normal) - for data from a normal distribution

Capability Analysis (Between/Within) - for data from a normal distribution and useful when variation in the data is due to both within and between subgroups

Capability Analysis (Weibull) - for data from a Weibull distribution

Capability Analysis (Binomial) - for data from a Binomial distribution

Capability Analysis (Poisson) - for data from a Poisson distribution

Example: Capability Analysis (Normal)

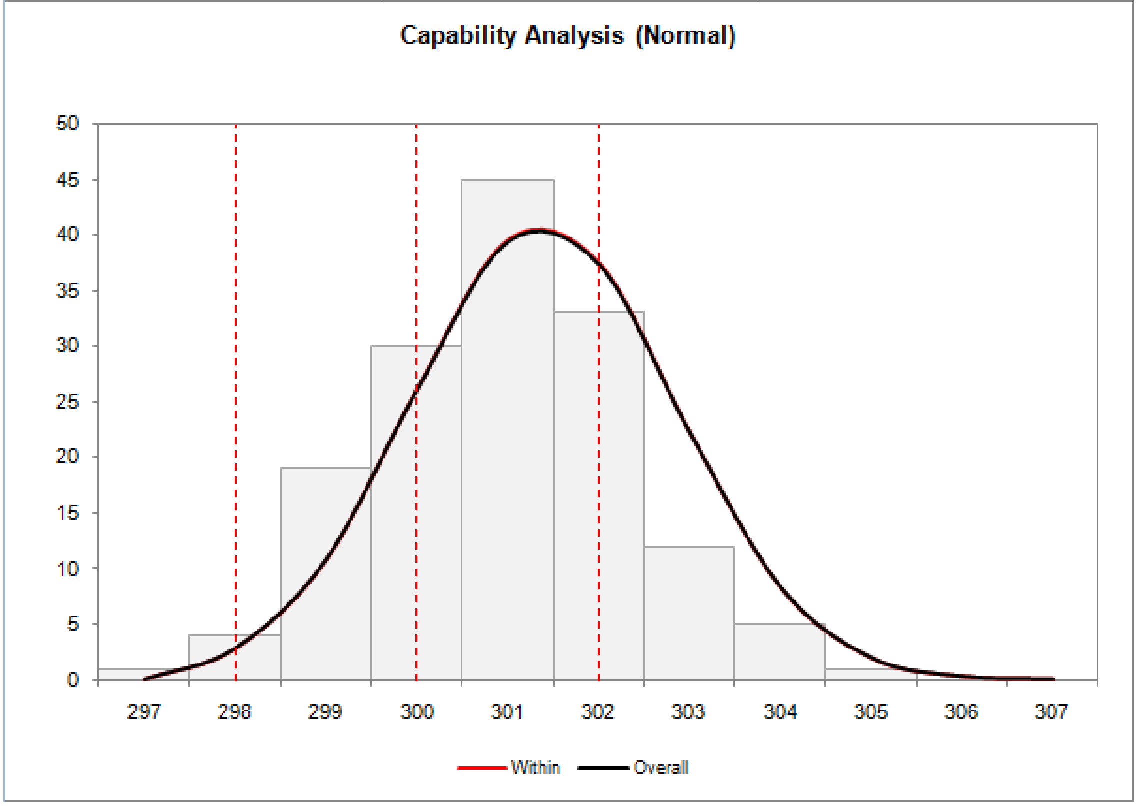
You work in manufacturing plant and you need to make sure that the diameter of the parts made is 300mm ± 3mm to meet technical specifications. You collected five samples each day for the last 30 days. You want to perform a capability study to evaluate if the process is capable of meeting the specifications.

Steps

1. Open data worksheet by choosing ProcessMA > Tools > Data
2. Choose ProcessMA > Quality Tools > Capability Analysis > Capability Analysis (Normal)
3. In Variable, select D - Diameter
4. In Constant Subgroup Size, enter 10
5. In Lower Specification Limit, enter 298
6. In Upper Specification Limit, enter 302
7. In Target, enter 300
8. Click OK

Results

Capability Analysis (Normal)					
Process Stats		**Within Capability**		**Overall Capability**	
USL	302	Cp	0.47	Pp	0.46
Target	300	CPU	0.26	PPU	0.26
LSL	298	CPL	0.67	PPL	0.67
Mean	300.89	Cpk	0.26	Ppk	0.26
Sample N	150	Cpm	0.40		
Std Dev (Within)	1.4309				
Std Dev (Overall)	1.4352				
Observed Perf		**Expected(W) Perf**		**Expected(O) Perf**	
PPM<LSL	20000.00	PPM<LSL	21875.18	PPM<LSL	22197.27
PPM>USL	200000.00	PPM>USL	217987.56	PPM>USL	218685.52
PPM Total	220000.00	PPM Total	239862.74	PPM Total	240882.79



Interpretation

The process does not meet the lower and upper specification limits. The process needs to be improved to reduce variation and also centered on the target.

7. Design of Experiments

ProcessMA provide tools for you to create factorial designs for experiment and ability to visualize and analyze experiment data to determine process changes that yield maximum returns.

Create Factorial Design – creates 2-level factorial (2-15 factors) or Plackett-Burman designs (2-47 factors), full or fractional designs, centre points, replicates and blocks.

Analyse Factorial Design - analyses the factorial design to fit a model. You can customize your model and also analyze blocking and curvature effects. You can also use effects plots and residual plots to assess model adequacy.

Factorial Plots - generate three types of factorial plots to help you visualize the effects, namely the main effects, interactions and cube. They can be used to help you visualise how the response relates to one or more factors

Example: Analyse Factorial Design

You want to investigate how temperature, intensity of light and type of catalyst affect the growth of organisms. You created a full factorial design for three factors and with three replicates. You ran the experiments and recorded the data.

Steps

1. Choose ProcessMA > DOE > Create Factorial Design
2. In Type of Design, choose 2-level factorial design
3. In Number of Factors, choose 3
4. In Design, choose Full Factorial, 8 Runs, 2^3
5. In Number of Center Points, choose 0
6. In Number of Replicates, choose 3
7. In Number of Blocks, choose 1
8. In Factors table for Factor 1
    a. In Type, choose Numeric
    b. In Name, enter Temp
    c. In Low, enter 10
    d. In High, enter 40
9. In Factors table for Factor 2
    a. In Type, choose Numeric
    b. In Name, enter Light
    c. In Low, enter 100
    d. In High, enter 300
10. In Factors table for Factor 3
    a. In Type, choose Text
    b. In Name, enter Catalyst
    c. In Low, enter P

   d. In High, enter Q

11. Collect data and enter in Column H
12. Choose ProcessMA > DOE > Analyze Factorial Design
13. In Response, select H - Response
14. Under Results Tab, check Show Pareto Plot of Effect
15. Click OK

Results

Design of Experiment:Response

Coef (Coded)

Term	Effect	Coef	SE Coef	T	P Value
Constant		389.9871	0.4646	839.43	0
A: Temp	24.9992	12.4996	0.4646	26.9048	0
B: Light	23.6508	11.8254	0.4646	25.4537	0
C: Catalyst	1.3858	0.6929	0.4646	1.4915	0.1553
AB	7.0492	3.5246	0.4646	7.5865	0
AC	0.3042	0.1521	0.4646	0.3274	0.7476
BC	-0.7408	-0.3704	0.4646	-0.7973	0.4369
ABC	0.5308	0.2654	0.4646	0.5713	0.5757

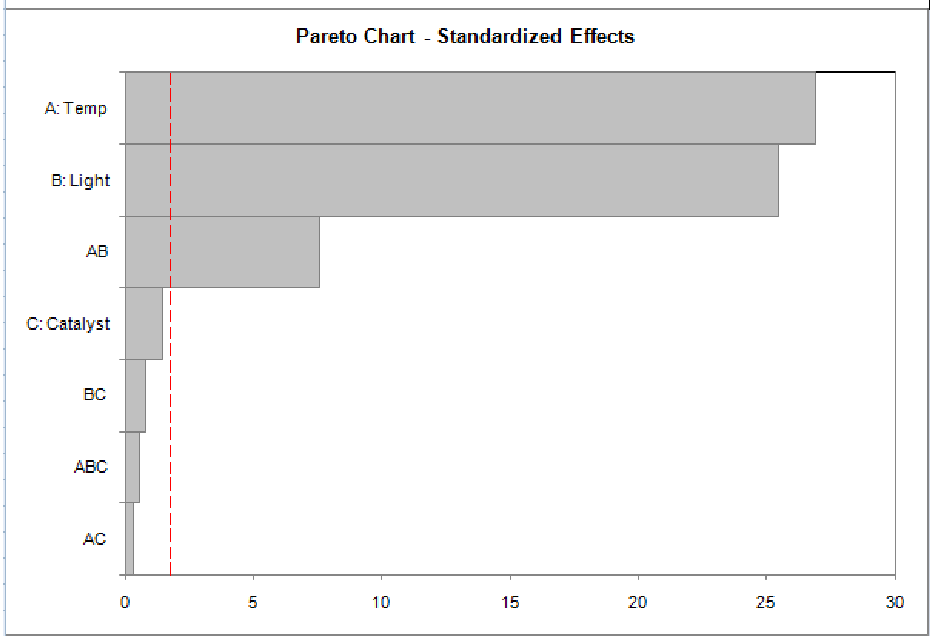
S	2.276
PRESS	186.4856
R-Sq	0.989
R-Sq(pred)	0.975
R-Sq(adj)	0.984

ANOVA (Coded)

Source	DoF	Seq SS	Adj SS	F	P-Value
Main Effects	3	7117.4447	7117.4447	457.9944	0
2-Way Interactions	3	301.9926	301.9926	19.4327	0
3-Way Interactions	1	1.6907	1.6907	0.3264	0.5757
Residual Error	16	82.8825	82.8825		
Total	23	7504.0105			

Coef (Uncoded)

Term	Coef
Constant	357.2522
A: Temp	0.3634
B: Light	0.0595
C: Catalyst	2.065
AB	0.0023
AC	-0.0253
BC	-0.0081
ABC	0.0002



Interpretation

From p values in the analysis of variance table, it suggests that the main effects and the 2-way interaction are significant while the 3-way interaction is not. From the p values in the estimated effects and coefficients, it suggests that only the two main effects (Temp and Light) and the 2-way interaction (Temp*Light) are significant.

8. Statistical Process Control

Choose from a wide range of control charts to track process statistics over time to identify common and special causes. In addition, you can customize 8 different tests for special causes. For charts that need normal data, you can use the Boxcox transformation tool to transforms non-normal data into normal data.

Variable Charts for Subgroup

Xbar - control chart of subgroup means. It is used to track the process level and detect signs of special causes.

R - control chart of subgroup ranges. It is used to track the process variation and detect signs of special causes. It is suitable for sample sizes 5 or less. For bigger sample sizes, the S Chart may be more appropriate.

S - control chart of subgroup standard deviations. It is used to track the process variation and detect signs of special causes. It is suitable for sample sizes larger than 5. For smaller sample sizes, the R Chart may be more appropriate.

Xbar-R - consist of is a control chart of subgroup means and a control chart of subgroup ranges. It is used to track both the process level and process variation at the same time, and detect signs of special causes.

Xbar-S - consists of is a control chart of subgroup means and a control chart of subgroup standard deviations. It is used to track both the process level and process variation at the same time, and detect signs of special causes.

I-MR-R/S - uses both between-subgroup and within-subgroup variations to generate three control charts, the individuals, moving range and R or S charts. These three charts can help to assess the process level, variation between samples and variation within samples respectively. It is useful when the overall process variation is due to both between subgroup variation and random error.

Zone - similar to the Xbar or individuals Chart. It plots a cumulative score based on zones. It is useful because 'out-of-control' is easy to identify, which is when cumulative score is greater than 8.

Variable Charts for Individuals

Individuals - control chart of individual observations. It is used to track the process level and detect signs of special causes when subgroup size is equals to 1.

Moving Range - control chart of moving ranges. It is used to track the process variation and detect signs of special causes with subgroup size is equals to 1.

I-MR - made up of an individuals Chart and Moving Range Chart. It allows you to track both process level and process variation at the same time and detect signs of special causes.

Z-MR - made up of a control chart of standardised individual observations and the Moving Range Chart. It allows you to track both process level and process variation at the same time. The Z-MR is useful for processes with insufficient data on each run to give a good estimate of process parameters. Individual observations are therefore standardised so that data collected from different runs can be evaluated on the same control chart.

Attribute Charts

P - control chart of proportion of defectives (number of defectives divided by the subgroup size). It is used to track the proportion defective and detect signs of special causes.

NP - control chart of number of defectives. It is used to track the number of defectives and detect signs of special causes.

C - control chart of the number of defects. It can be used to track the number of defects and detect signs of special causes.

U - control chart of number of defects per unit sampled. It is used to track the number of defects per unit sampled and detect signs of special causes.

Time-weighted Charts

Moving Average - control chart of moving averages (of individuals or subgroup means). It is used to track the process level and detect signs of special causes.

EWMA - control chart of exponentially weighted moving averages (of individuals or subgroup means). Each point contains a weighted effect from all the previous points. It can be used to track shifts away from the target.

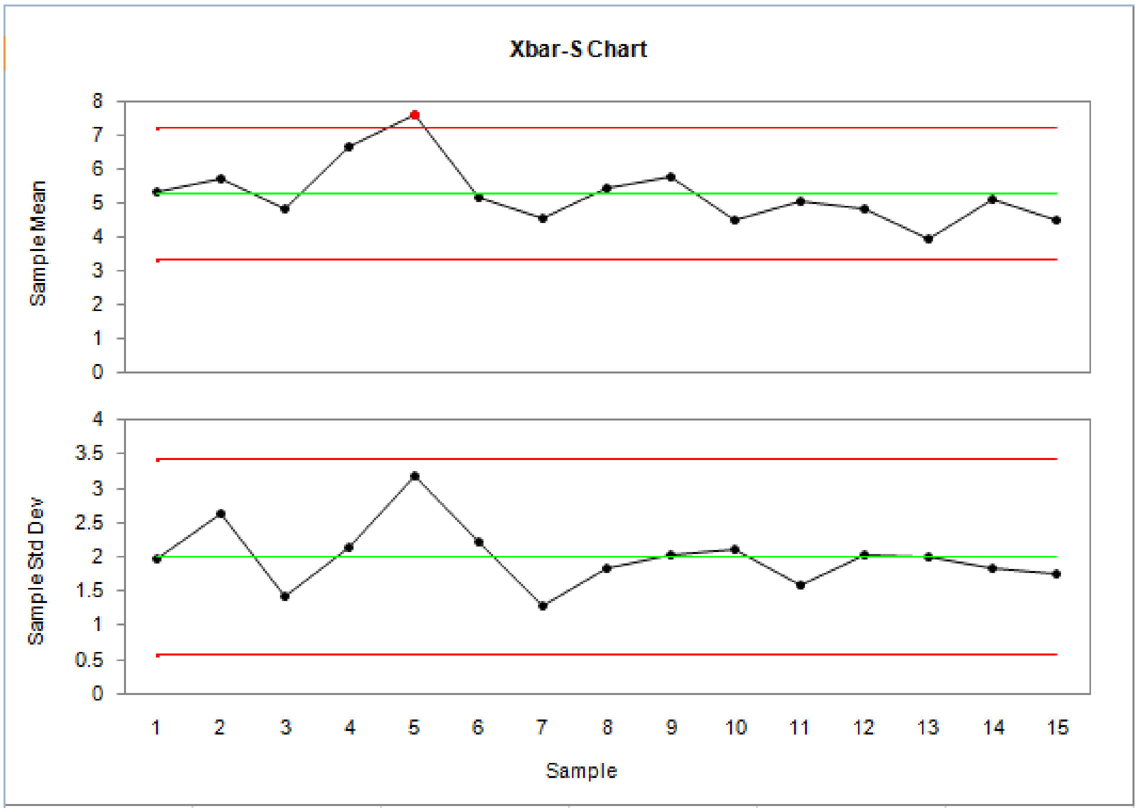
Example: Xbar-S Chart

You are the branch manager of a bank and you need to ensure that time customers spent waiting in the queue is in control. For each day you took 10 measurements on the waiting time. You want to generate a Xbar-S Chart to track the process level and variation.

Steps

1. Open data worksheet by choosing ProcessMA > Tools > Data
2. Choose ProcessMA > Control Charts > Variables Charts for Subgroups > Xbar-S
3. In Variable, select V - Waiting Time
4. In Constant Subgroup Size, enter 10
5. Click OK

Results



Interpretation

The fifth point of the Xbar Chart lies outside of the control limit suggesting a possible special cause. The points in the S Chart is random and within the control limit, suggesting that the variation of the process is stable.

9. Reliability and Survival

Use the Reliability & Survival Analysis to calculate the lifespan of the products and predict failure rates for right or arbitrary censored data.

Parametric Distribution Analysis - fit distribution to your data, estimate percentile, survival probabilities and draw probability, survival, cumulative failure and hazard plots

Nonparametric Distribution Analysis – estimate cumulative failure probabilities, hazard rates and draw survival, cumulative failure and hazard plots. Suitable if no distribution fits your data.

Accelerated Life Testing - investigate the relationship between failure time and an accelerating variable

Regression with Life Data - assesses relationship between predictors and failure time.

Example: Accelerated Life Test

You work in a manufacturing plant making widgets and you want to find out the deterioration of widgets. You tested the widgets at higher temperatures to accelerate deterioration and collected their failure times. You want to extrapolate to 50 degree Celsius, which are temperatures the widgets normally operate at. It is known that the relationship between temperature and failure time follows the Arrhenius relationship.

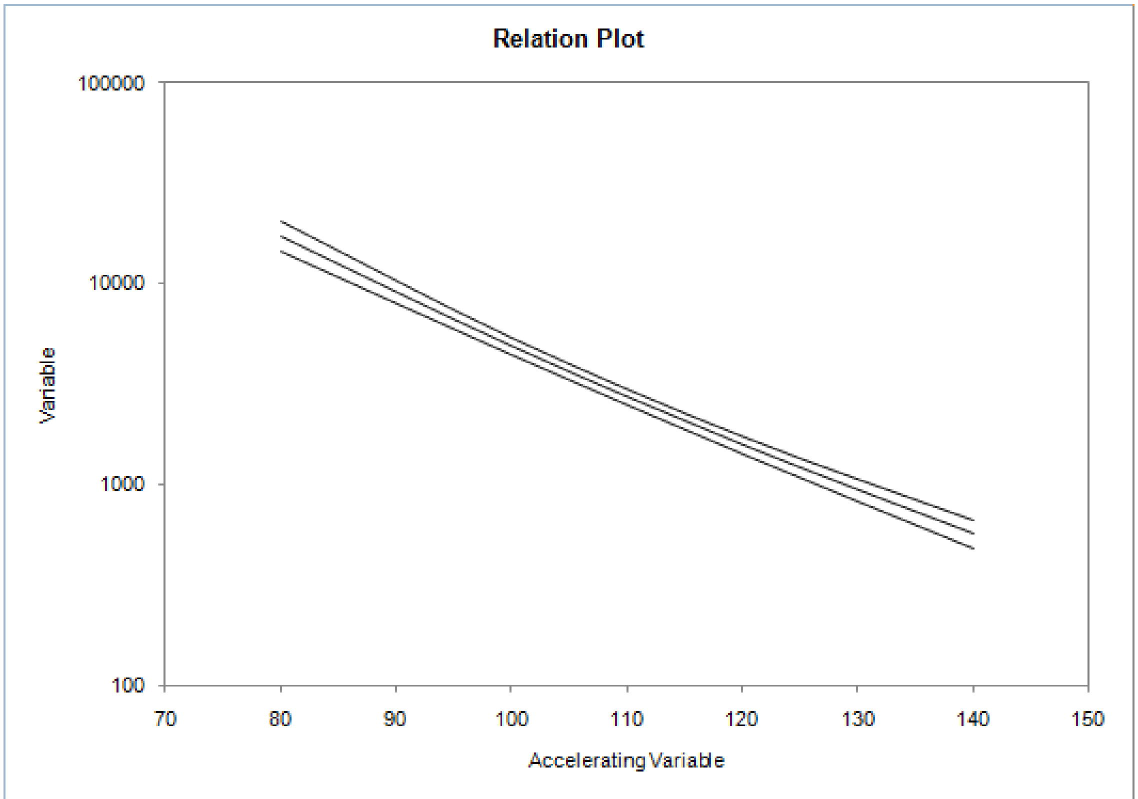
Steps

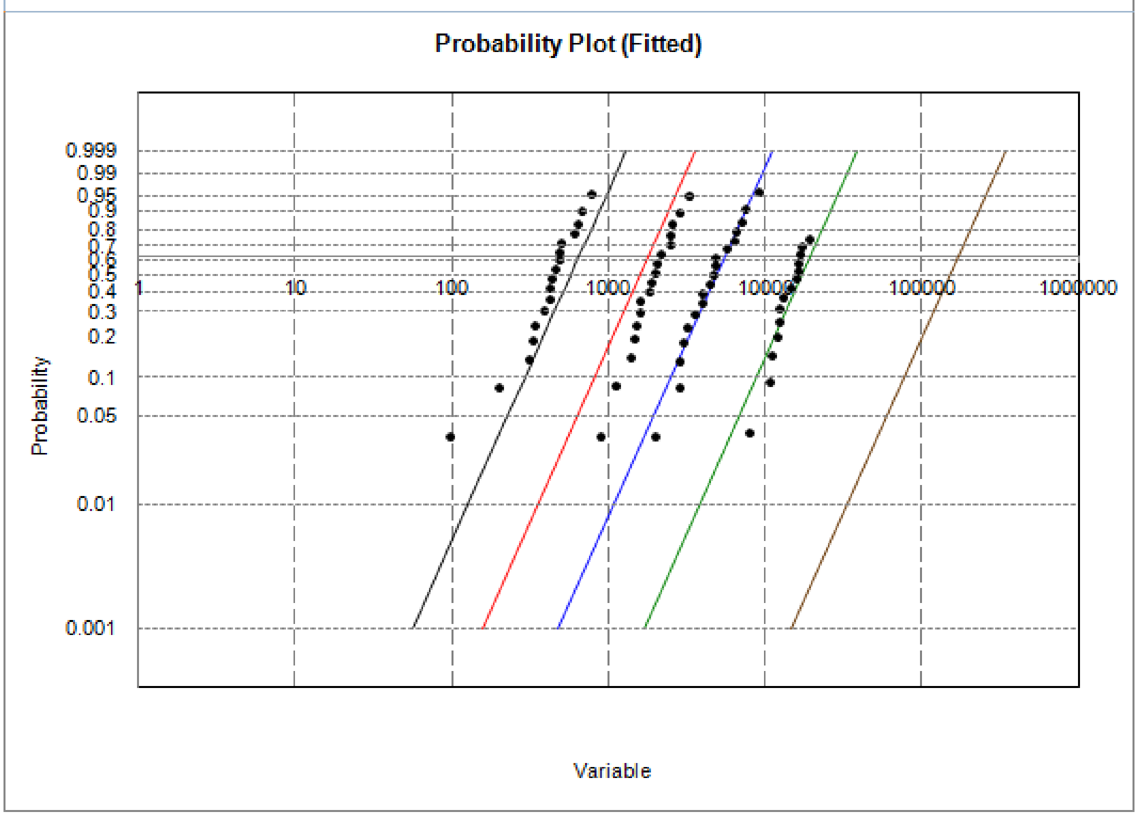
1. Open data worksheet by choosing ProcessMA > Tools > Data
2. Choose ProcessMA > Reliability and Survival > Accelerated Life Testing
3. In Variable, select CI - Times
4. In Assumed Distribution, choose Weibull
5. In Accelerating Variable, select CJ - Temp
6. In Relationship, choose Arrhenius
7. Under Censor Tab, in Censor, select CK - Cen
8. Under Censor Tab, in Censor Value, choose C
9. Under Result Tab, in New Predictor Values, enter 50
10. Under Graph Tab, check Probability Plot (Fitted)
11. Click OK

Results

Accelerated Life Testing

Censoring	C					
Estimation Method	Maximum likelihood					
Relationship	Arrhenius					
Distribution	Weibull					
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------
Regression						
Predictor	Coefficient	Standard Error	Z	P	95% CI-Lower	95% CI-Upper
Intercept	-13.5351	0.9255	-14.625	0	-15.349	-11.7212
Acc. Variable	0.7126	0.0305	23.3774	0	0.6529	0.7724
Shape	2.8177	0.2562			2.3156	3.3199
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------
Percentiles						
Percent	Acc. Variable	Percentile	Standard Error	95% CI Lower	95% CI Upper	
50	50	150965.6225	26540.5469	106962.7042	213070.7087	
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------
Percentiles (Individu						
Acc Variable	Scale	Shape	AD*	Failure	Censor	
140	511.7907	3.0501	1.2125	17	3	
120	2237.2884	3.5795	1.2088	17	3	
100	5551.127	2.849	1.1224	18	2	
80	17514.4395	3.9525	23.1214	14	6	
-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------


Relation Plot
100000
10000
1000
100
Variable
70
80
90
100
110
120
130
140
150
Accelerating Variable


Probability Plot (Fitted)
0.999
0.99
0.95
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.01
0.001
Probability
1
10
100
1000
10000
100000
1000000
Variable

Interpretation

From the table of percentiles, you can see that at 50 degrees Celsius, widgets will last 150966 hours at 50% percentile. Note: Y-axis of relation plot and X-axis of probablity plot is manually changed to log scale.

10. Quality Tools

ProcessMA also include the following quality tools to help you in every step of your project. These tools are interactive designed to make work easy for users. Refer to the help file for more information for visit our website (http://www.processma.com) for video demonstrations.

- Process Mapping for process analysis and value stream analysis (Draw as you type or use the toolbar)
- Gantt chart for project management
- Mind-mapping for root cause analysis and brainstorming
- Project templates to simply project documentation
    - Project Charter
    - SIPOC
    - Data Collection Plan
    - C&E Matrix
    - Value Add Analysis
    - Waste Analysis
    - Prioritizing Solutions
    - Pugh Matrix
    - FMEA
    - Pairwise Comparison
    - QFD
    - Fishbone Diagram for Manufacturing Industry
    - Fishbone Diagram for Service Industry

11. ProcessMA Interactive

ProcessMA Interactive uses custom-defined formulas, named range charts and pre-formatted spreadsheets to present a dynamic, interactive and user-friendly interface. When you create a new tool from ProcessMA interactive, a new pre-formatted worksheet will be created. As you enter data into designated columns, your analysis results will be computed and displayed dynamically. If charts are present, they will also dynamically plot and display the results. The following are the key features:

Automatic Re-calculation - With ProcessMA Interactive, analysis results are automatically re-calculated when you change your data and options without having to repeat the analysis process.

Dynamic Charts - Charts are also dynamic. This feature is most useful for charts you need to update regularly such as the control charts. As you enter new data, the charts are dynamically re-plotted without the need to re-create them.

Combining Related Tools in One - Related tools are now combined for easy access and to avoid duplication such as DOE (Design, Analyze & Factorial Plots), Power and Sample Size (All test types), etc

How to use

Learning how to use ProcessMA Interactive is simple. Once you learn the know-how for one tool, the rest are similar. The following uses the Pareto Chart tool as an example to walkthrough the process.

First, choose from the ProcessMA menu to select a tool of your choice

1. Choose ProcessMA > Interactive > New
2. In Category, choose Graphs
3. In Tool, choose Pareto Chart
4. Check Load Example if you wish to populate worksheet with data for the example
5. Click OK

A new pre-formatted spreadsheet will be created. Like in most tools, the Pareto Chart tool has 3 sections shown highlighted in Red, Blue and Green

The Green section labeled as Data, is for you to enter the data to be analyzed

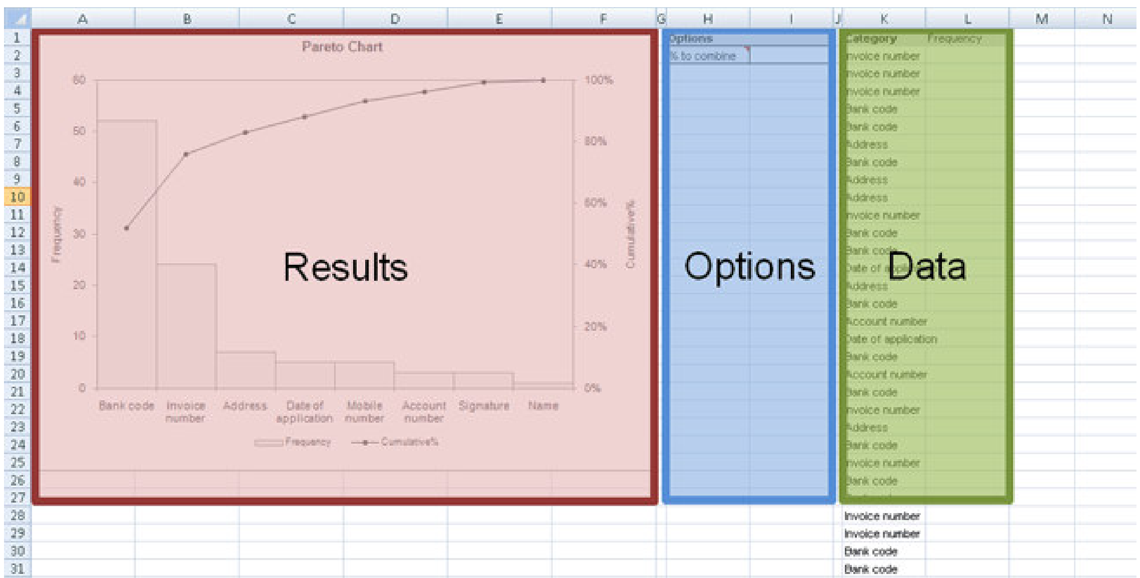
- Data must be entered in columns with the first row as the column label. Column labels can be changed as required
- Hover the mouse cursor over the column labels (commented cells with red triangle at it's upper right corner) to view specific information
- Data columns with labels in bold are required whereas data columns with labels not in bold are optional

The Blue section labeled as Options, is for you to enter option values to customize your results

- Option fields are organized in rows with labels on the left and values on the right
- Hover the mouse cursor over the labels (commented cells with red triangle at it's upper right corner) to view specific information

The Red section labeled as Results, is where the results are displayed

- As you enter data in the Data (Green) section or enter values in Options (Blue) section, the results are dynamically computed and displayed
- If you are interested in the data used for plotting the charts (e.g. residuals and fitted values for residuals plots), there are usually located in Columns AB and thereafter



Example: Descriptive Statistics

You collected data on time (in minutes) to resolve a customer enquiry in a call centre. You want to describe this set of data. You want to use ProcessMA Interactive tool because you intend to collect and add more data in the next few days.

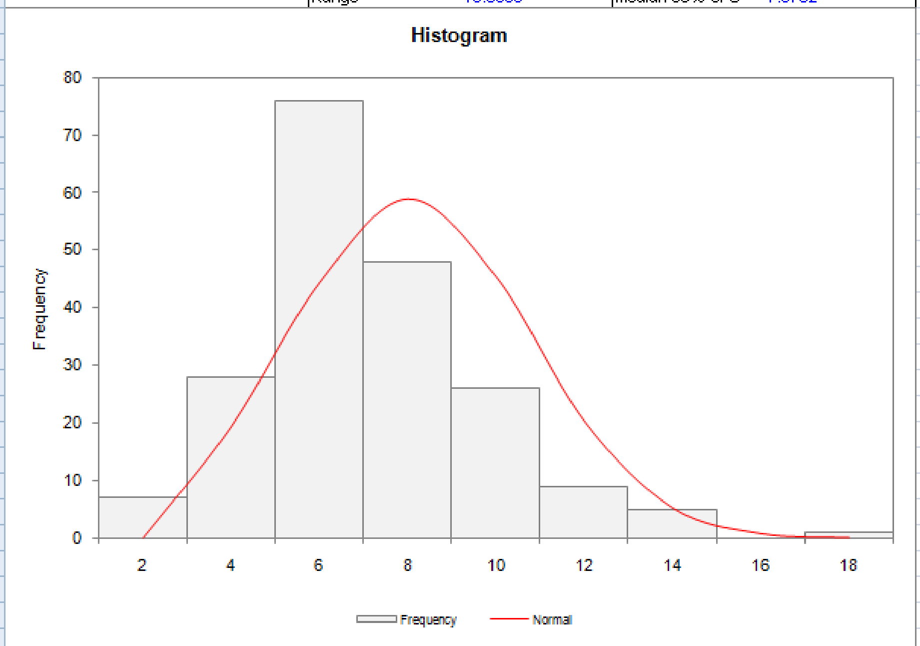
Steps

1. Choose ProcessMA > Interactive > New
2. In Category, select Statistics
3. In Tool, select Descriptive Statistics
4. Enter data in Column H (labeled as Variable)

Results

Descriptive statistics and a histogram of the data will be displayed in Columns A:F.

Descriptive Statistics					
Mean	7.0430	Min	1.4100	Mean 95% CI-L	6.6736
Std Dev	2.6487	1st Quartile	5.3200	Mean 95% CI-U	7.4123
Variance	7.0157	Median	6.5650	Sigma 95% CI-L	2.4121
Count	200	3rd Quartile	8.4600	Sigma 95% CI-U	2.9372
Sum	1408.5900	Max	17.7400	Median 95% CI-L	6.3138
		Range	16.3300	Median 95% CI-U	7.0762



Variable
9.62
8.25
8.6
6.34
6.44
10.26
1.41
10.13
10.68
9.65
2.92
7.35
11.28
10.42
7.03
13.32
11.4
3.24
12.92
6.96
8.19
10.19
3.16
8.7
7.76
6.41
8.94
9.14
6.1
6.25
10.86
10.8
8.68
14.6