



آموزش کنترل کیفیت آماری در نرم افزار Minitab

علی فدایی تفرشی
زمستان ۱۴۰۱



سر فصل مطالب

معرفی نرم افزار و محیط آن

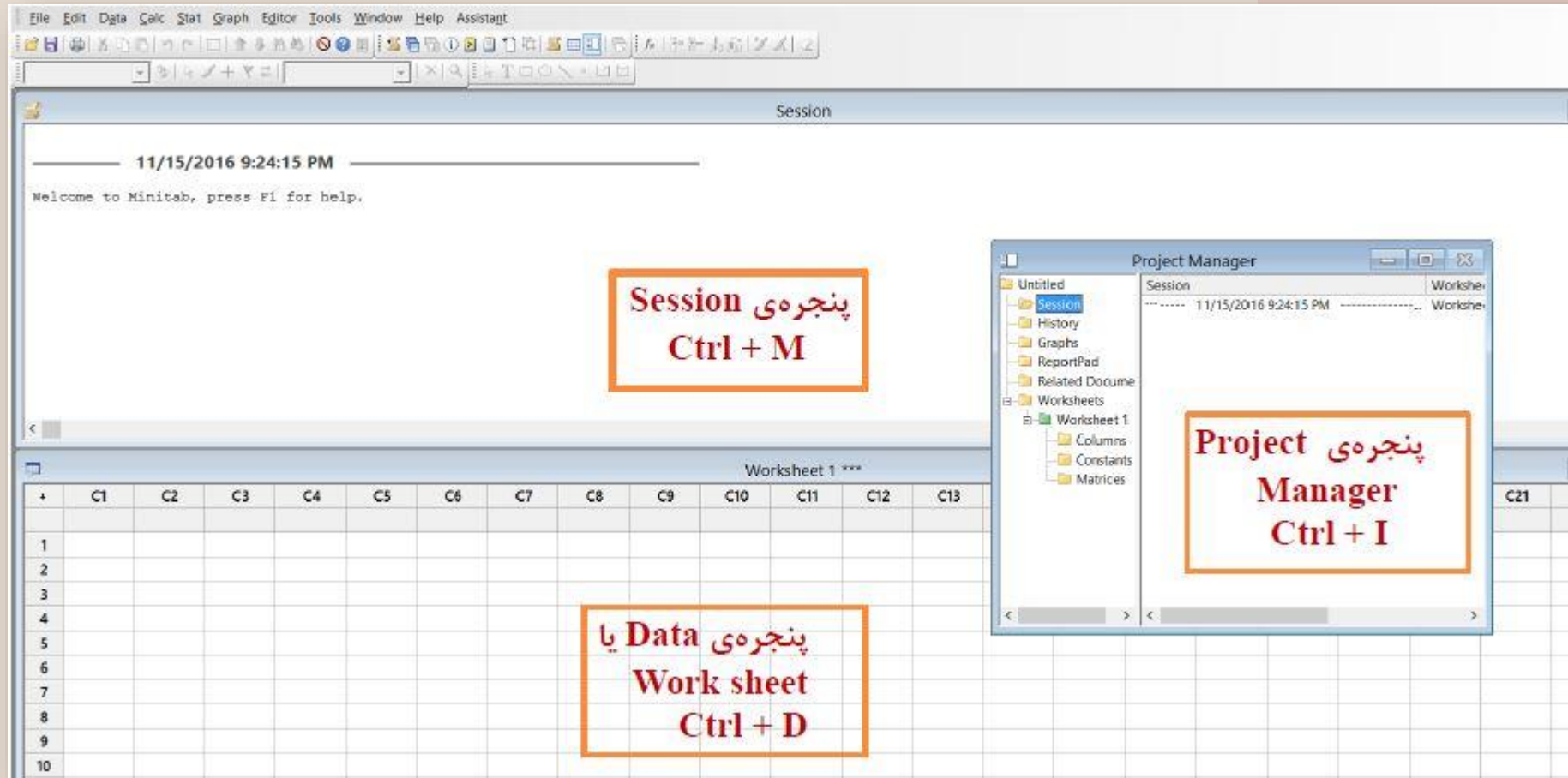
آزمون ها و پارامترهای آماری

ابزار های کنترل فرآیند آماری

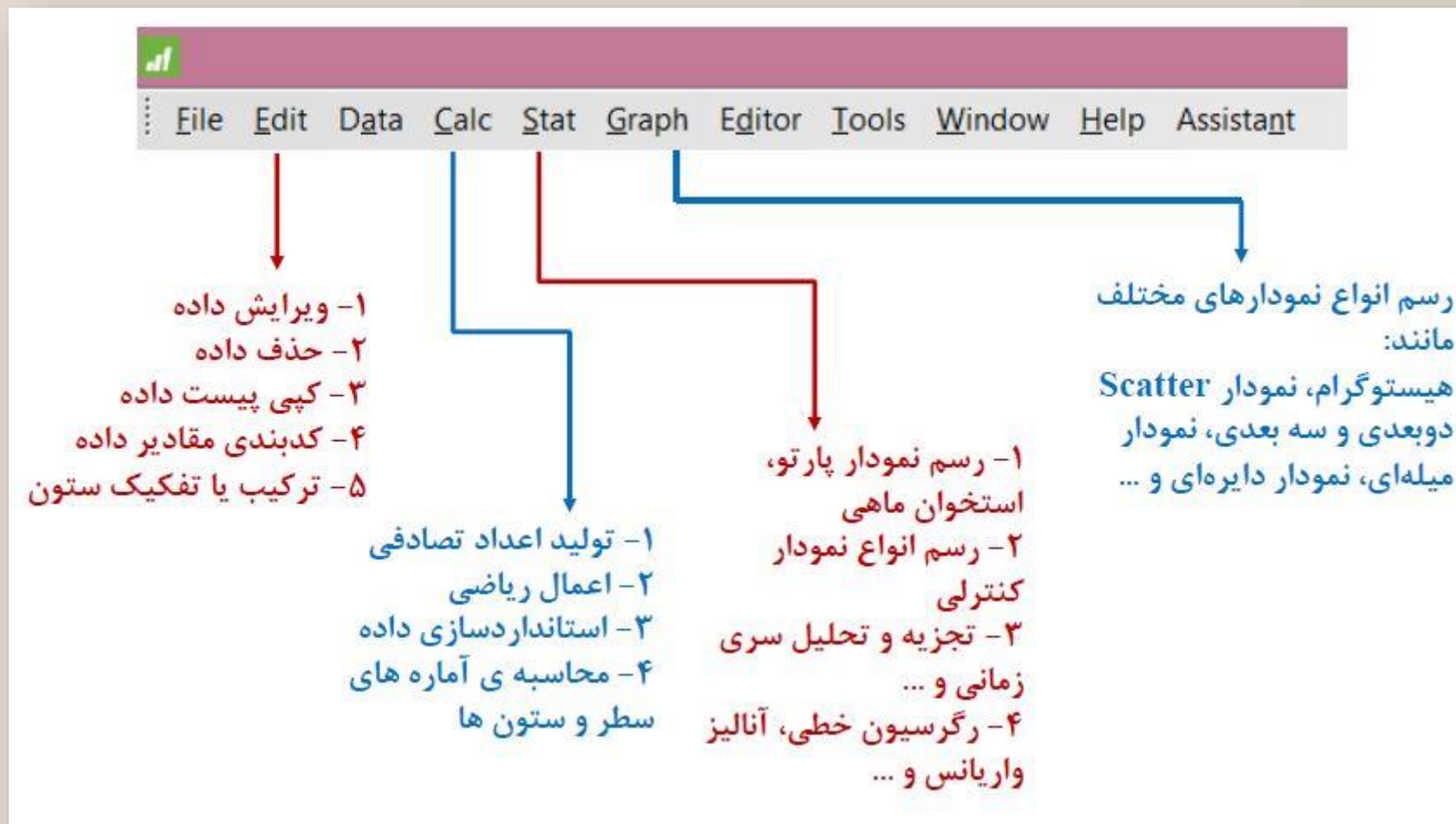
نمودار های کنترلی

معرفی نرم افزار و محیط آن

پنجره های اصلی



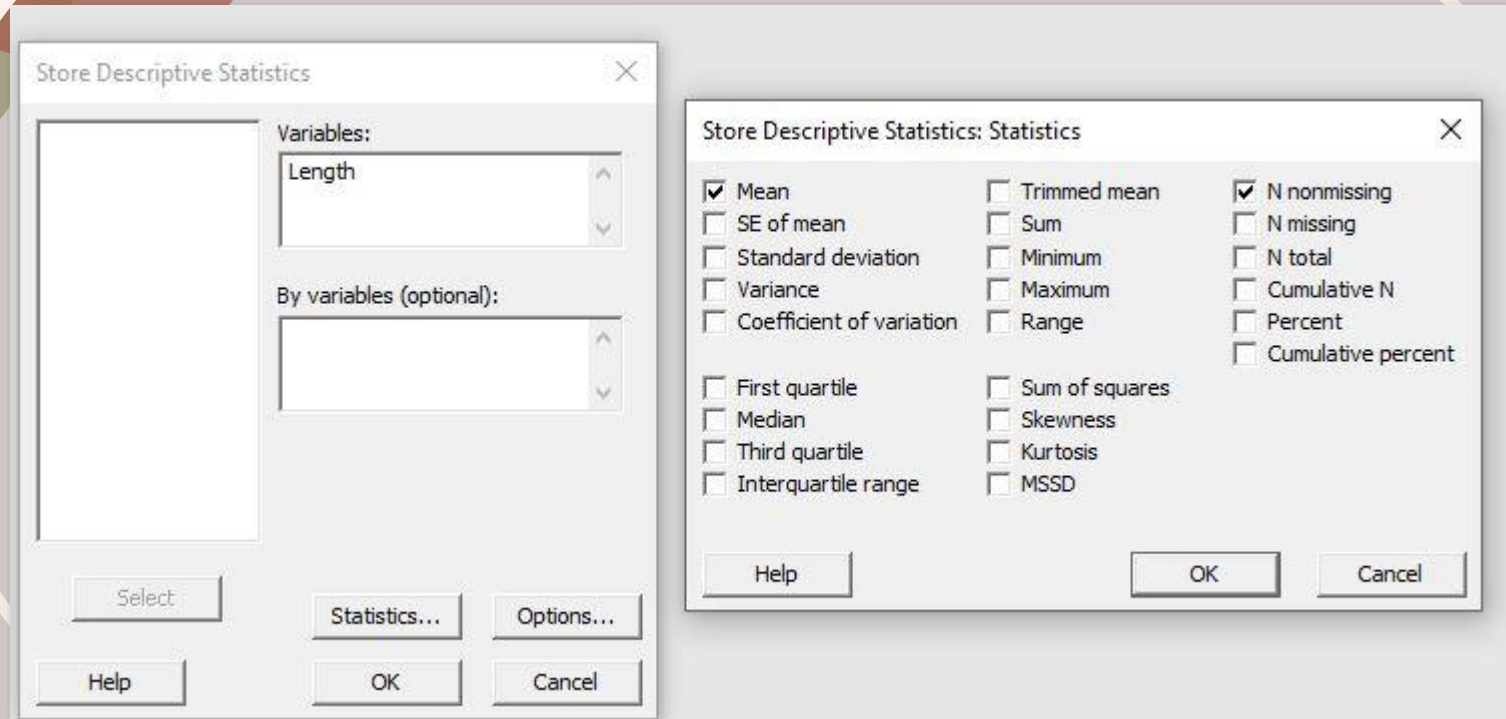
منو های اصلی



آزمون ها و پارامترهای آماری

محاسبه پارامترهای آماری

Stat → Basic Statistic → Store Descriptive Statistic → Statistics...



ضریب همبستگی

Stat → Basic Statistic → correlation

| | Length | Supp1 | Supp2 |
|----|--------|-------|-------|
| 3 | 598.0 | 600.0 | 598.4 |
| 4 | 601.4 | 599.8 | 600.0 |
| 5 | 599.4 | 600.0 | 596.8 |
| 6 | 600.0 | 600.0 | 602.8 |
| 7 | 600.2 | 598.8 | 600.8 |
| 8 | 601.2 | 598.2 | 603.6 |
| 9 | 598.4 | 599.4 | 604.2 |
| 10 | 599.0 | 599.6 | 602.4 |
| 11 | 601.2 | 599.4 | 598.4 |
| 12 | 601.0 | 599.4 | 599.6 |
| 13 | 600.8 | 600.0 | 603.4 |
| 14 | 597.6 | 598.8 | 600.6 |
| 15 | 601.6 | 599.2 | 598.4 |
| 16 | 599.4 | 599.4 | 598.2 |
| 17 | 601.2 | 599.6 | 602.0 |
| 18 | 598.4 | 599.0 | 599.4 |
| 19 | 599.2 | 599.2 | 599.4 |
| 20 | 598.8 | 600.6 | 600.8 |
| 21 | 601.4 | 598.8 | 600.8 |

Correlation

C1 Length
C2 Supp1
C3 Supp2

Variables:
Supp1 Supp2

Select

Options...

Graphs...

Results...

Help

OK

Cancel

توزیع داده ها

Stat → Quality Tools → Individual Distribution Identification

CAMSHAFT.MTW

Distribution Identification for Length

Goodness of Fit Test

| Distribution | AD | P | LRT P |
|-------------------------|--------|--------|-------|
| Normal | 4.430 | <0.005 | |
| Box-Cox Transformation | 4.421 | <0.005 | |
| Lognormal | 4.432 | <0.005 | |
| 3-Parameter Lognormal | 4.491 | * | 0.786 |
| Exponential | 45.671 | <0.003 | |
| 2-Parameter Exponential | 12.581 | <0.010 | 0.000 |
| Weibull | 4.210 | <0.010 | |
| 3-Parameter Weibull | 4.234 | <0.005 | 1.000 |
| Smallest Extreme Value | 4.206 | <0.010 | |
| Largest Extreme Value | 4.412 | <0.010 | |
| Gamma | 4.492 | <0.005 | |
| 3-Parameter Gamma | 4.515 | * | 1.000 |
| Logistic | 4.383 | <0.005 | |
| Loglogistic | 4.385 | <0.005 | |
| 3-Parameter Loglogistic | 4.383 | * | 0.807 |

Individual Distribution Identification

Data are arranged as

☒ Single column: Length

Subgroup size: 5

(use a constant or an ID column)

☐ Subgroups across rows of:

☒ Use all distributions and transformations

☒ Specify

☒ Distribution 1: Normal

☒ Distribution 2: Exponential

☒ Distribution 3: Weibull

☒ Distribution 4: Gamma

Box-Cox...
Johnson...
Options...
Results...

OK
Cancel

Select
Help

| ↓ | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 |
|---|--------|-------|-------|----|----|----|----|----|----|-----|-----|-----|-----|
| | Length | Supp1 | Supp2 | | | | | | | | | | |
| 1 | 601.4 | 598.0 | 601.6 | | | | | | | | | | |
| 2 | 601.6 | 599.8 | 600.4 | | | | | | | | | | |
| 3 | 598.0 | 600.0 | 598.4 | | | | | | | | | | |
| 4 | 601.4 | 599.8 | 600.0 | | | | | | | | | | |
| 5 | 599.4 | 600.0 | 596.8 | | | | | | | | | | |

بررسی تصادفی بودن داده ها

Stat → Quality Tools → Run Chart

Run Chart

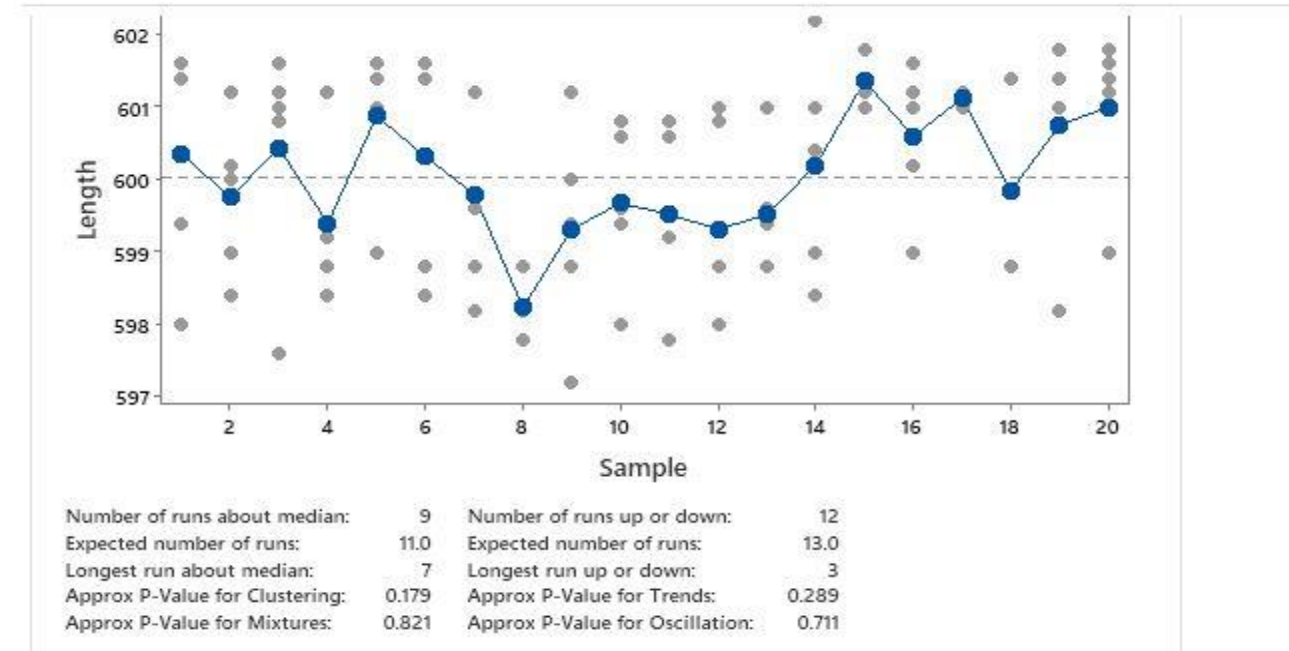
C1 Length
C2 Supp1
C3 Supp2

Data are arranged as
☒ Single column: Length
Subgroup size: 5
(use a constant or an ID column)
☐ Subgroups across rows of:

For data in subgroups
☐ Plot subgroup means
☒ Plot subgroup medians

Select OK Cancel Help

Run Chart of Length



| ↓ | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 |
|---|--------|-------|-------|----|----|----|----|----|----|-----|
| | Length | Supp1 | Supp2 | | | | | | | |
| 1 | 601.4 | 598.0 | 601.6 | | | | | | | |
| 2 | 601.6 | 599.8 | 600.4 | | | | | | | |
| 3 | 598.0 | 600.0 | 598.4 | | | | | | | |
| 4 | 601.4 | 599.8 | 600.0 | | | | | | | |
| 5 | 599.4 | 600.0 | 596.8 | | | | | | | |

آزمون تصادفی بودن

Stat → Nonparametrics → Runs Test

Runs Test: Length

Descriptive Statistics

| N | K | Number of Observations | |
|-----|---------|------------------------|-------|
| | | $\leq K$ | $> K$ |
| 100 | 600.072 | 46 | 54 |

$K = \text{sample mean}$

Test

Null hypothesis H_0 : The order of the data is random
Alternative hypothesis H_1 : The order of the data is not random

Number of Runs

| Observed | Expected | P-Value |
|----------|----------|---------|
| 45 | 50.68 | 0.250 |

Runs Test

Variables: Length

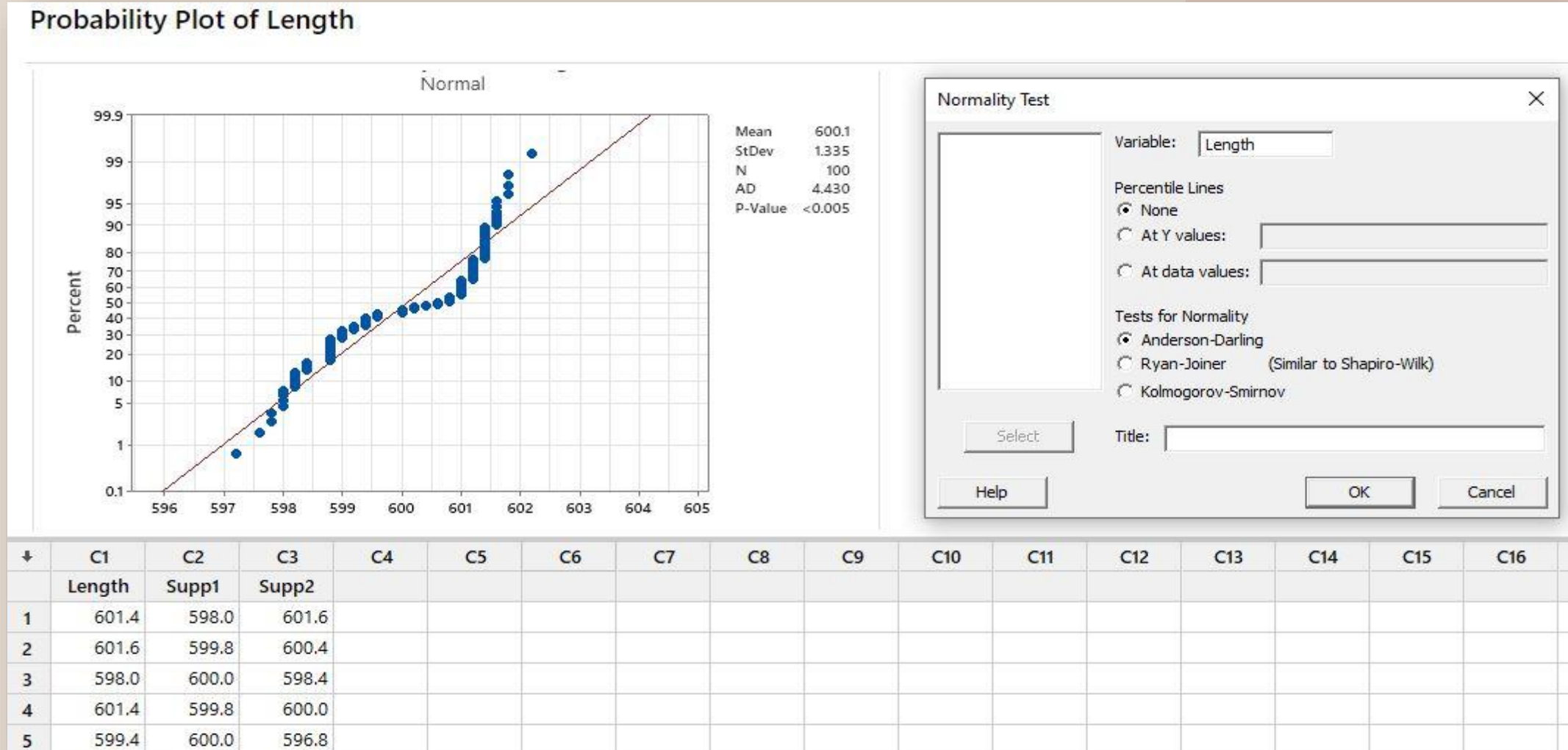
☒ Above and below the mean
☐ Above and below:

Select OK Cancel

| ↓ | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 |
|---|--------|-------|-------|----|----|----|----|----|----|-----|-----|
| | Length | Supp1 | Supp2 | | | | | | | | |
| 1 | 601.4 | 598.0 | 601.6 | | | | | | | | |
| 2 | 601.6 | 599.8 | 600.4 | | | | | | | | |
| 3 | 598.0 | 600.0 | 598.4 | | | | | | | | |
| 4 | 601.4 | 599.8 | 600.0 | | | | | | | | |
| 5 | 599.4 | 600.0 | 596.8 | | | | | | | | |

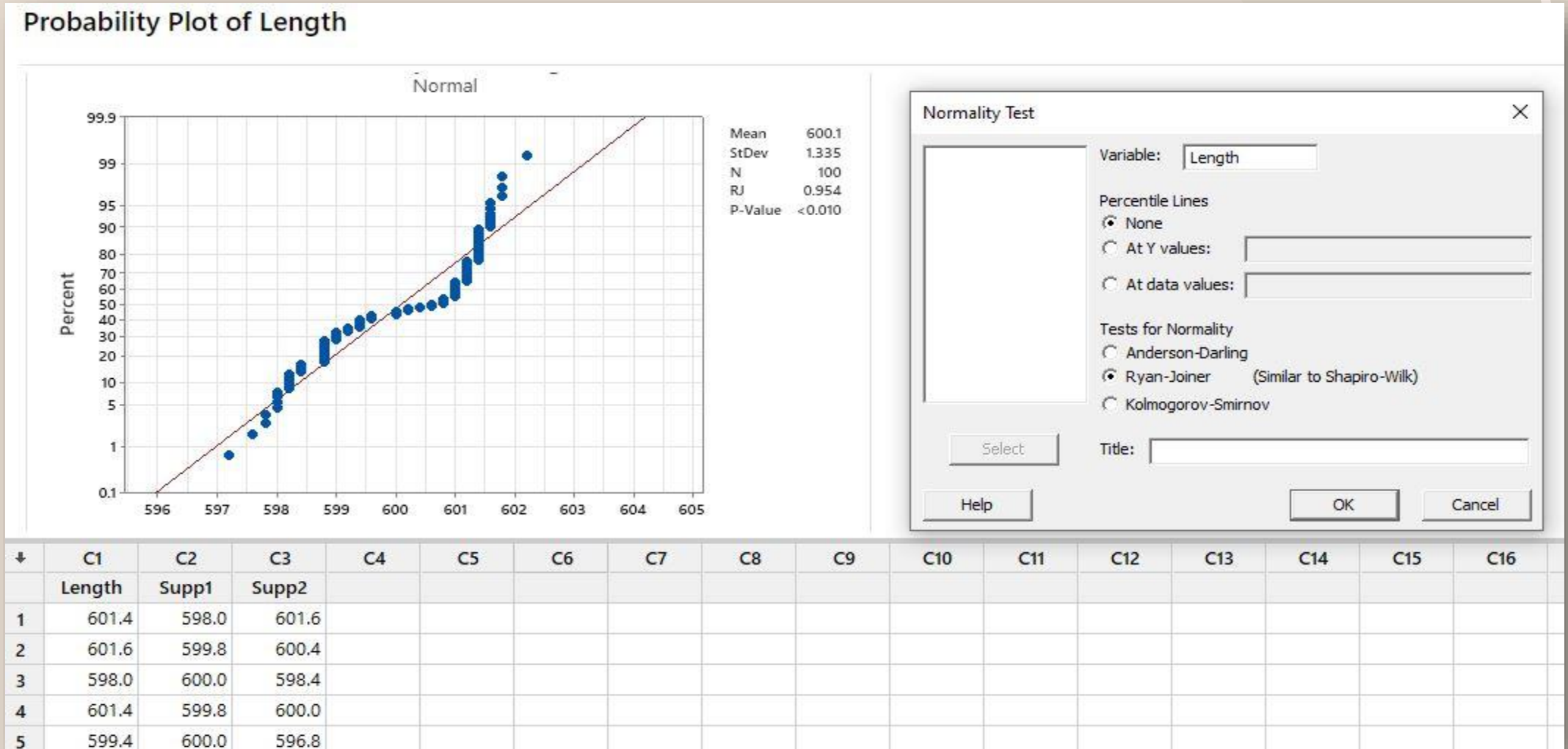
آزمون نرمال بودن

Stat → Basic Statistic → Normality Test → Anderson-Darling



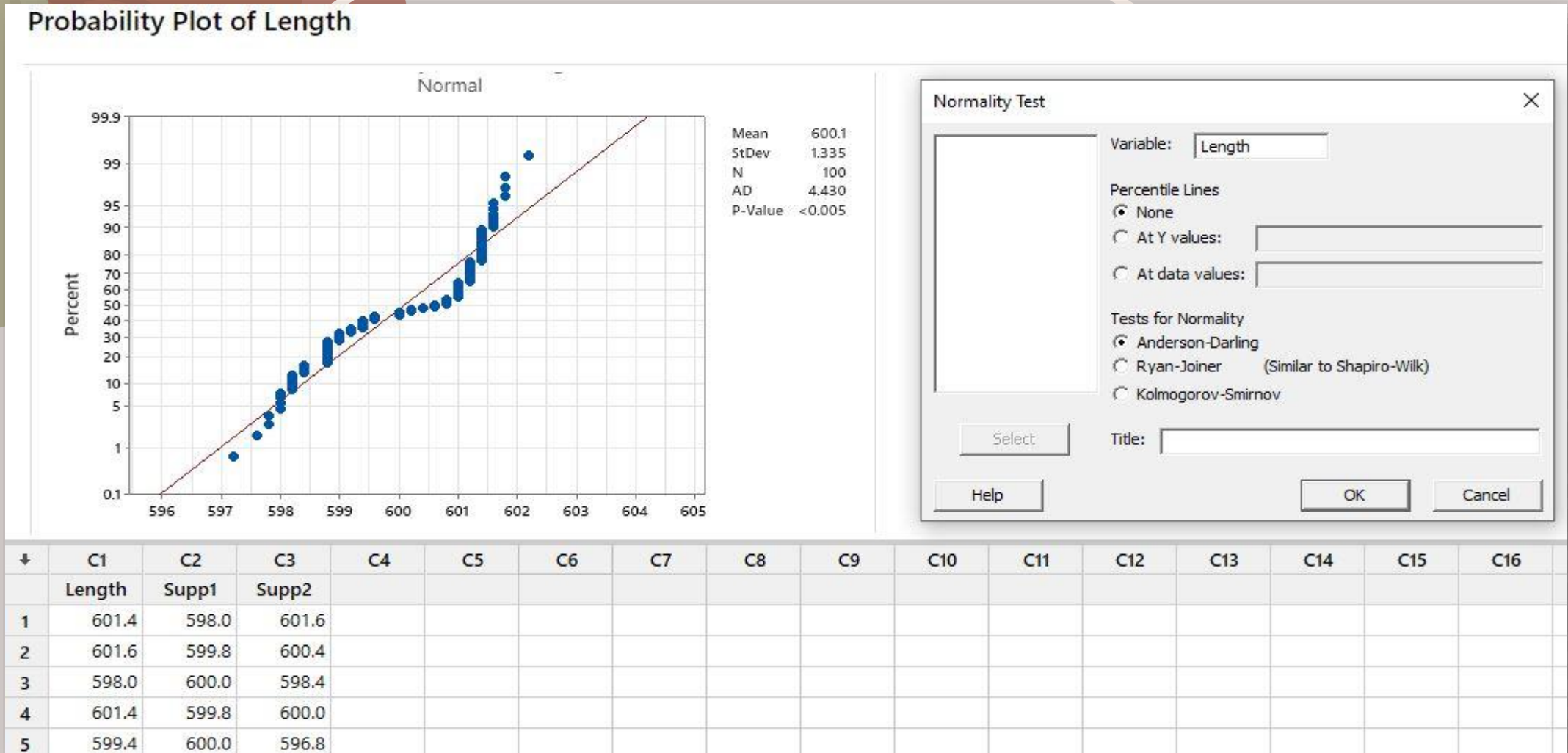
آزمون نرمال بودن

Stat → Basic Statistic → Normality Test → Ryan-Joiner



آزمون نرمال بودن

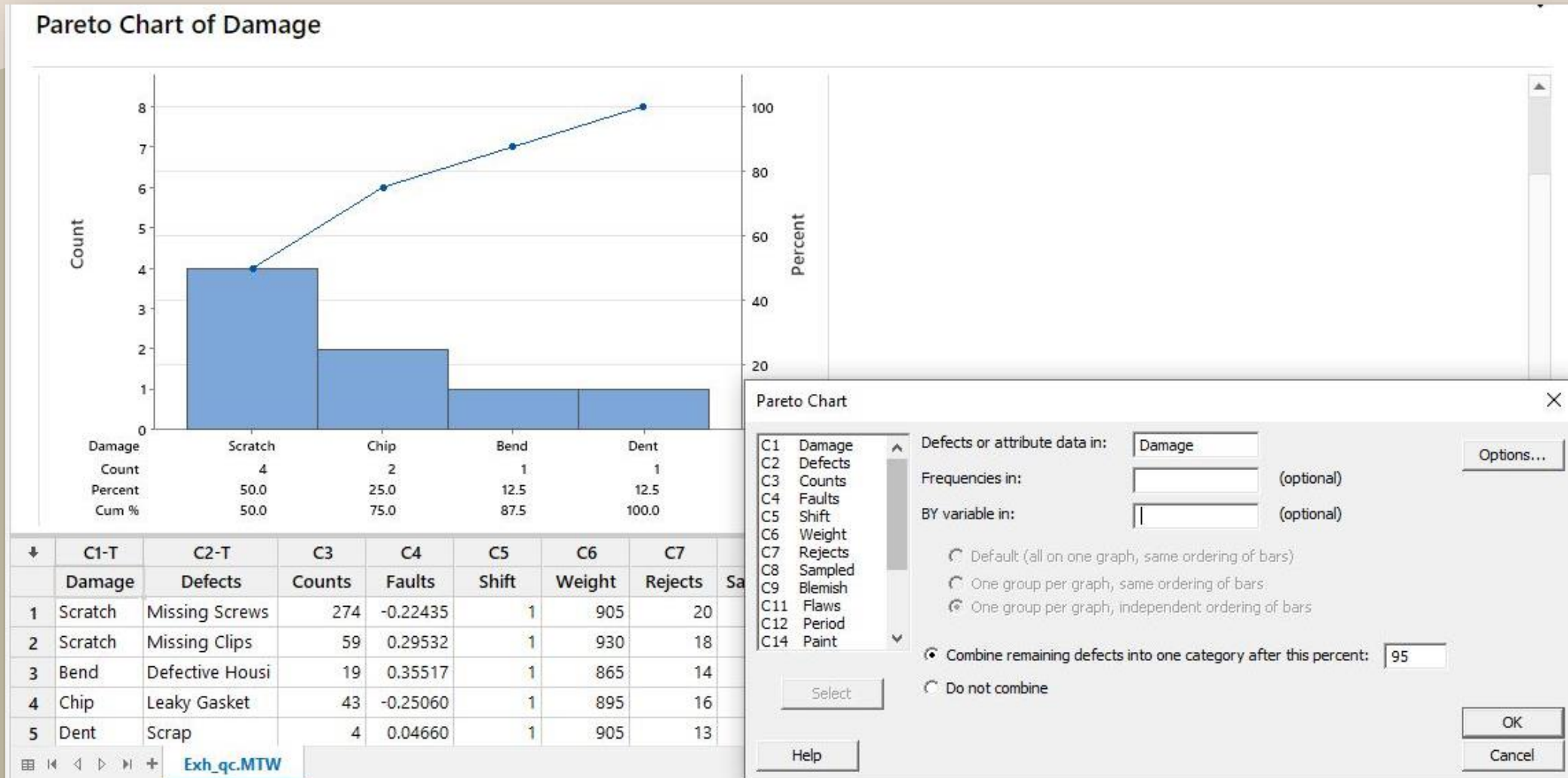
Stat → Basic Statistic → Normality Test → Kolmogorov-Smirnov



ابزارهای کنترل فرآیند آماری

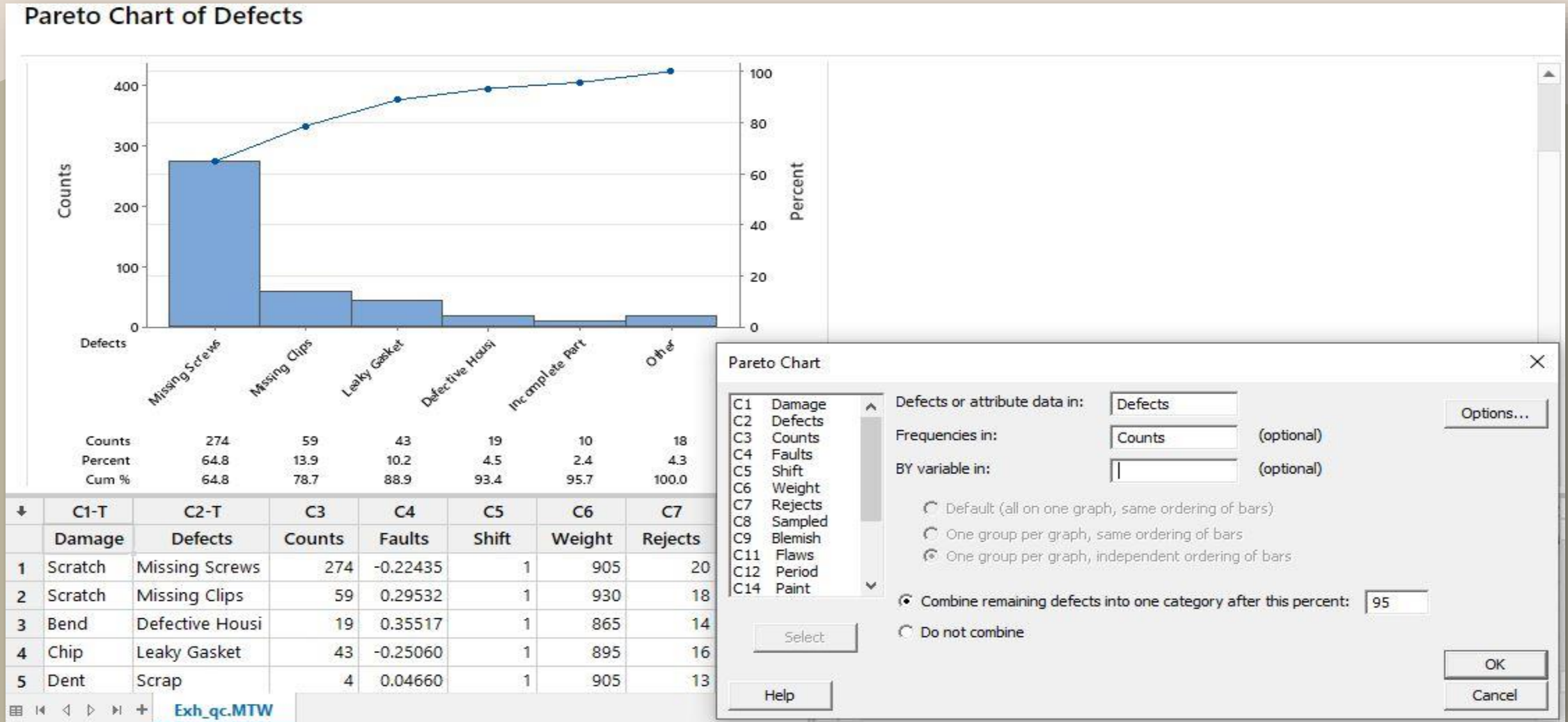
نمودار پارتو

Stat —————> Quality Tools —————> Pareto Chart



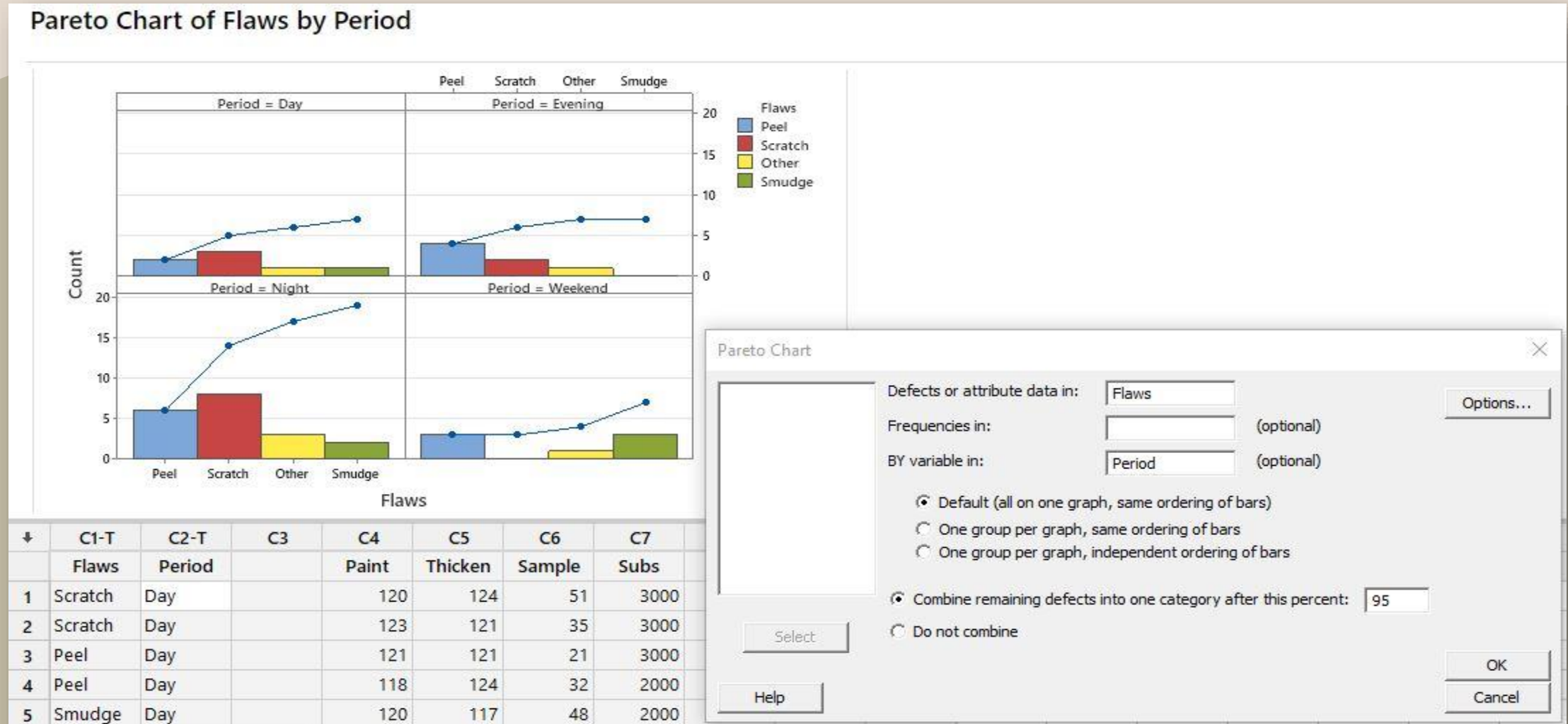
نمودار پارتو

Stat → Quality Tools → Pareto Chart



نمودار پارتو

Stat —————> Quality Tools —————> Pareto Chart



نمودار استخوان ماهی / ایشیکاوا / علت و معلول

Stat → Quality Tools → Cause & Effect

WORKSHEET 1

Cause-and-Effect Diagram

Cause-and-Effect Diagram

| Branch | In column | Causes | Label | Sub... |
|--------|-----------|-------------|--------------|--------|
| 1 | In column | Personal | Personnel | Sub... |
| 2 | In column | Machine | Machines | Sub... |
| 3 | In column | Material | Material | Sub... |
| 4 | In column | Method | Methods | Sub... |
| 5 | In column | Measure | Measurements | Sub... |
| 6 | In column | Environment | Environment | Sub... |
| 7 | In column | | | Sub... |
| 8 | In column | | | Sub... |
| 9 | In column | | | Sub... |
| 10 | In column | | | Sub... |

Effect:

Title:

☒ Do not label the branches

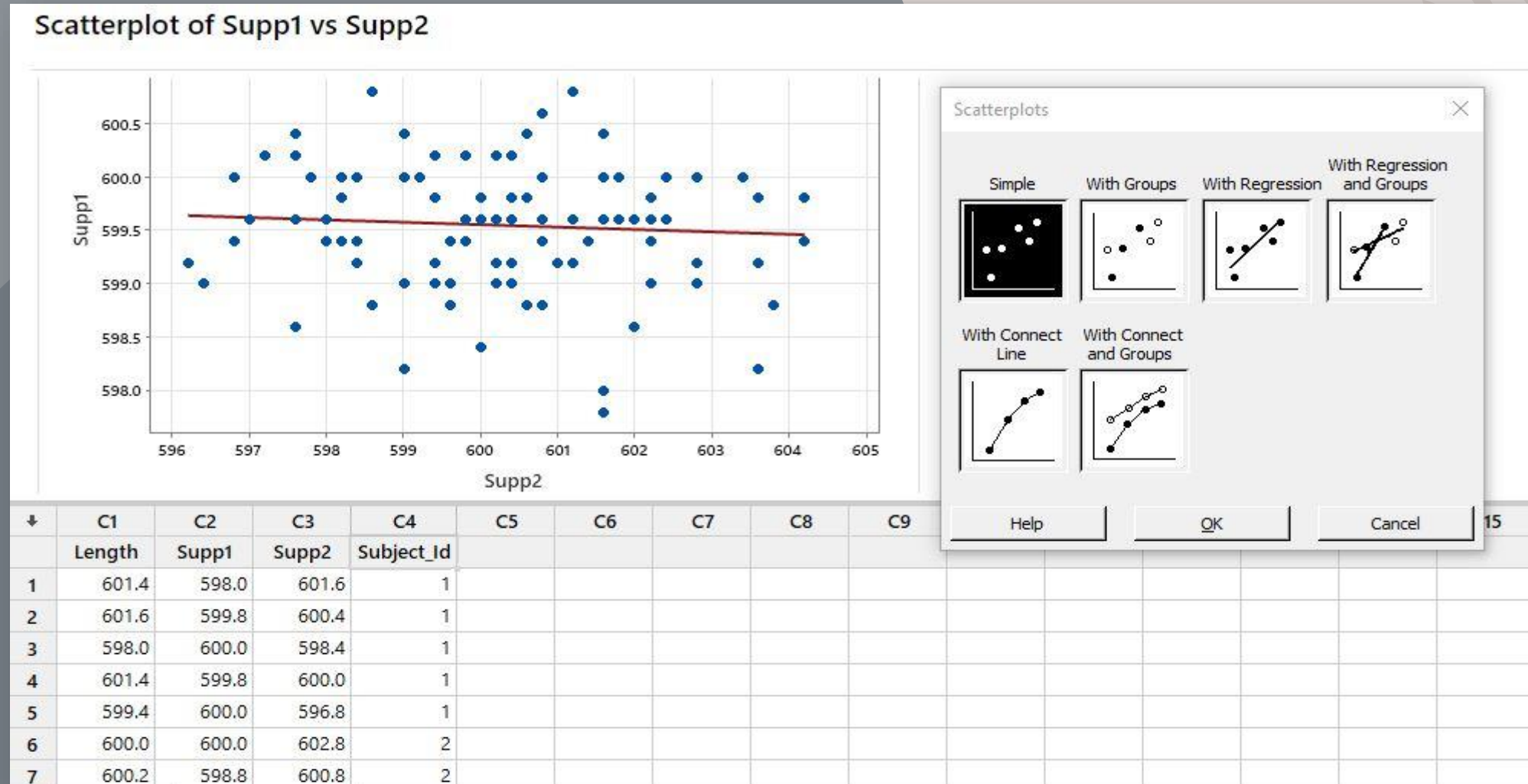
☐ Do not display empty branches

OK Cancel

| → | C1-T | C2-T | C3-T | C4-T | C5-T | C6-T | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 |
|---|-----------|-------------|-------------|-------------|-------------|-------------|----|----|----|-----|-----|-----|-----|-----|-----|
| | Personal | Machine | Material | Method | Measure | Environment | | | | | | | | | |
| 1 | causal 1p | causal 1mac | causal 1mat | causal 1met | causal 1mea | causal 1e | | | | | | | | | |
| 2 | causal 2p | causal 2mac | causal 2mat | causal 2met | causal 2mea | causal 2e | | | | | | | | | |
| 3 | causal 3p | causal 3mac | causal 3mat | causal 3met | causal 3mea | | | | | | | | | | |
| 4 | causal 4p | causal 4mac | causal 4mat | | causal 4mea | | | | | | | | | | |
| 5 | causal 5p | | causal 5mat | | causal 5mea | | | | | | | | | | |
| 6 | causal 6p | | causal 6mat | | | | | | | | | | | | |
| 7 | causal 7p | | | | | | | | | | | | | | |

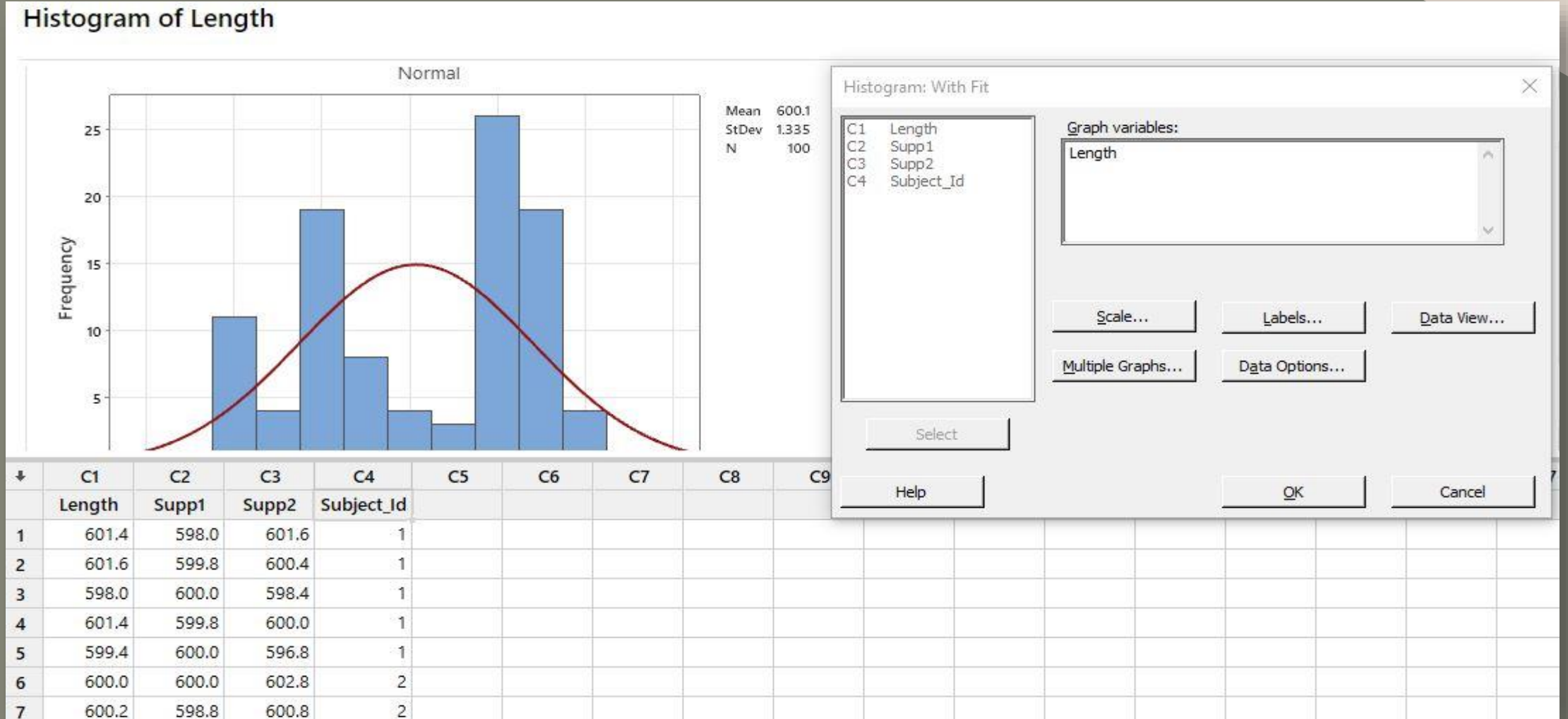
نمودار پراکندگی

Graph → Scatter Plot



هیستوگرام

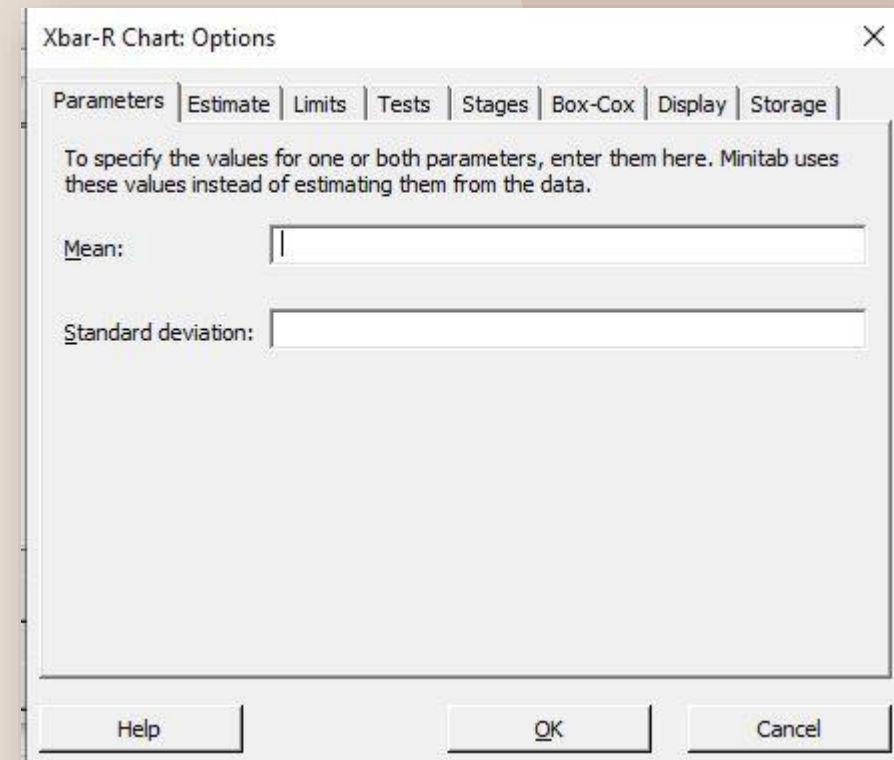
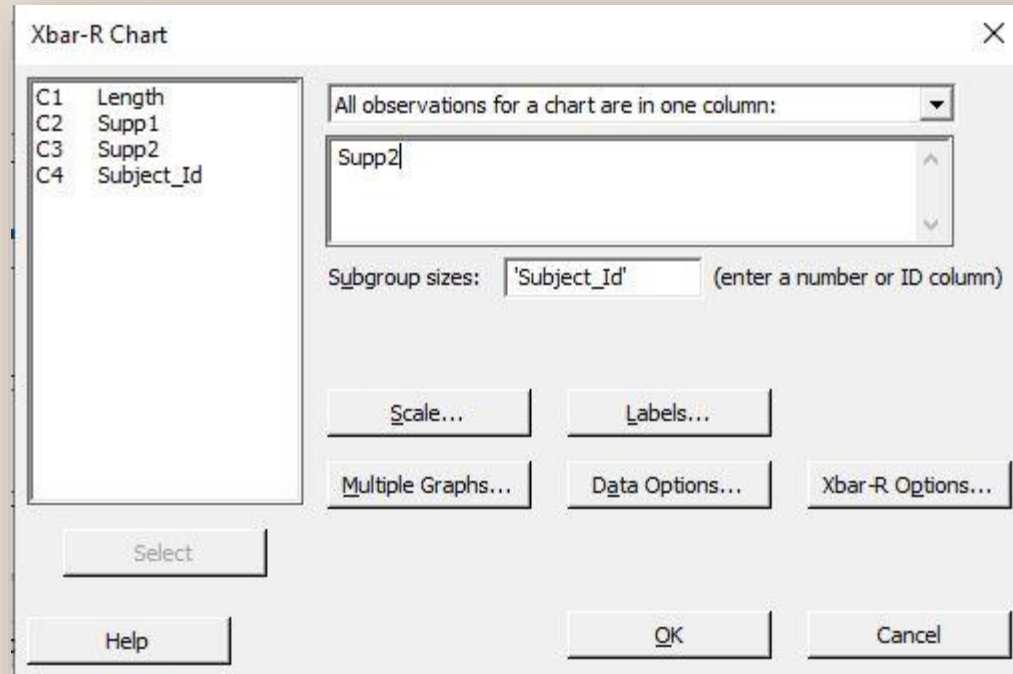
Graph → Histogram



نمودار های کنترلی

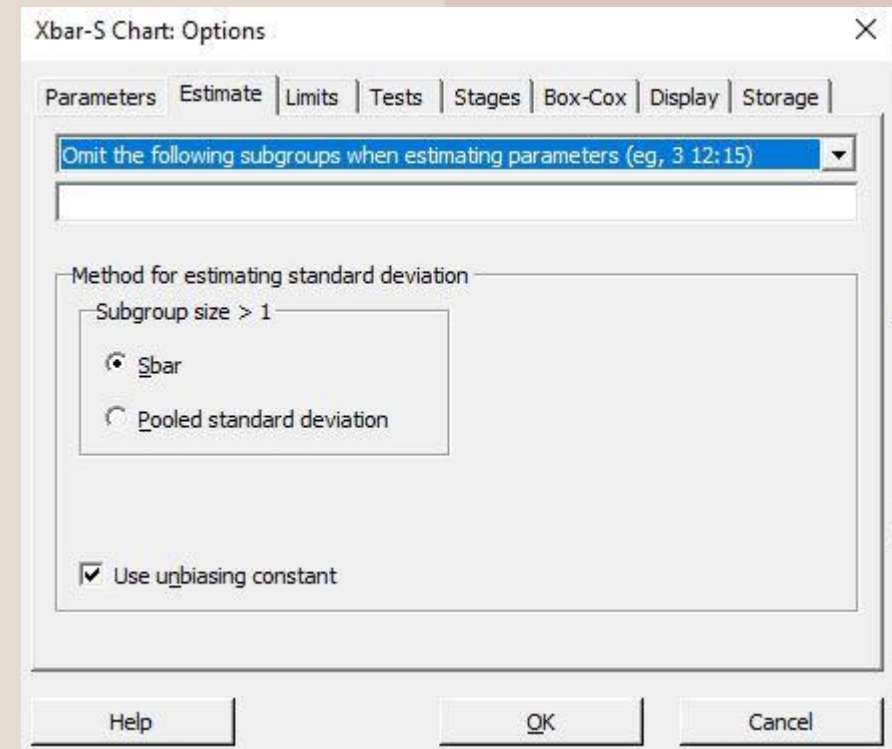
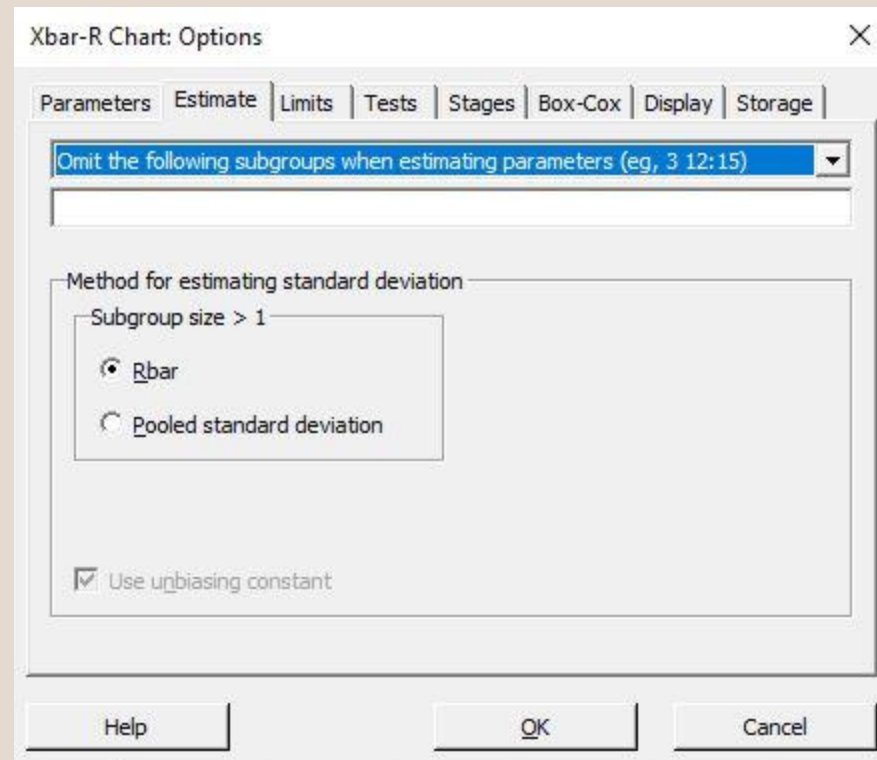
نمودار Xbar-R/S

Stat → Control Charts → Variables Charts for Subgroup → Xbar-R/S



نمودار Xbar-R/S

Stat → Control Charts → Variables Charts for Subgroup → Xbar-R/S



نمودار Xbar-R/S

Stat → Control Charts → Variables Charts for Subgroup → Xbar-R/S

Xbar-R Chart: Options

Parameters | Estimate | Limits | Tests | Stages | Box-Cox | Display | Storage

Display additional σ limits at
These multiples of the standard deviation:

Place bounds on control limits of Xbar chart

☐ Lower standard deviation limit bound:

☐ Upper standard deviation limit bound:

Place bounds on control limits of R chart

☐ Lower standard deviation limit bound:

☐ Upper standard deviation limit bound:

When subgroup sizes are unequal, calculate control limits

☒ Using actual sizes of the subgroups

☐ Assuming all subgroups have size:

Help OK Cancel

Xbar-R Chart: Options

Parameters | Estimate | Limits | Tests | Stages | Box-Cox | Display | Storage

Perform selected tests for special causes

☒ 1 point > K standard deviations from center line

☐ K points in a row on same side of center line

☐ K points in a row, all increasing or all decreasing

☐ K points in a row, alternating up and down

☐ K out of K+1 points > 2 standard deviations from center line (same side)

☐ K out of K+1 points > 1 standard deviation from center line (same side)

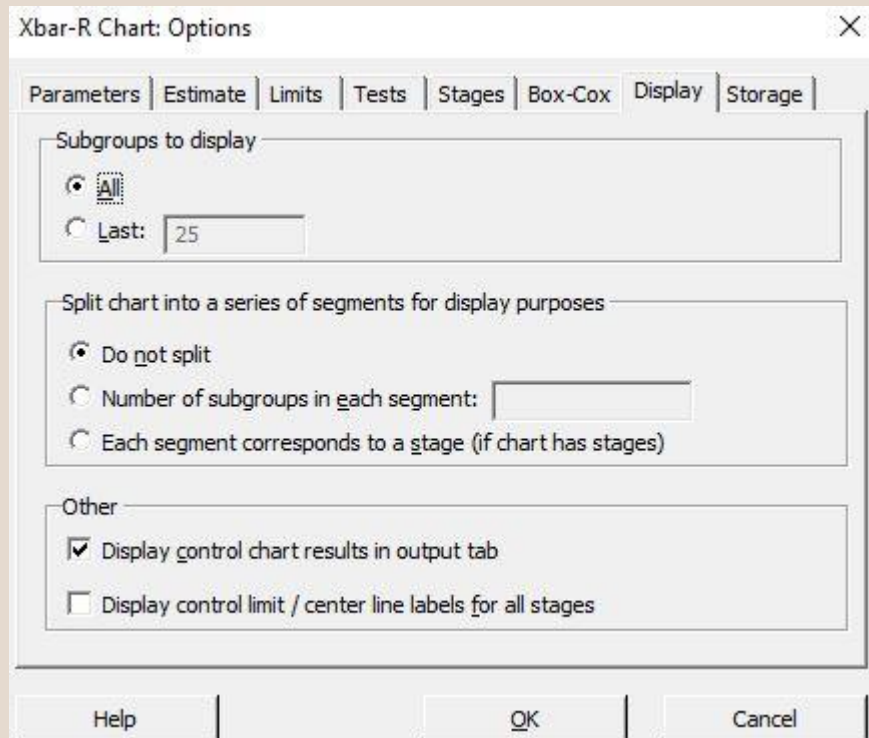
☐ K points in a row within 1 standard deviation of center line (either side)

☐ K points in a row > 1 standard deviation from center line (either side)

Help OK Cancel

نمودار Xbar-R/S

Stat → Control Charts → Variables Charts for Subgroup → Xbar-R/S



Xbar-R Chart: Options

Parameters | Estimate | Limits | Tests | Stages | Box-Cox | Display | Storage

Subgroups to display

☒ All

☐ Last: 25

Split chart into a series of segments for display purposes

☒ Do not split

☐ Number of subgroups in each segment:

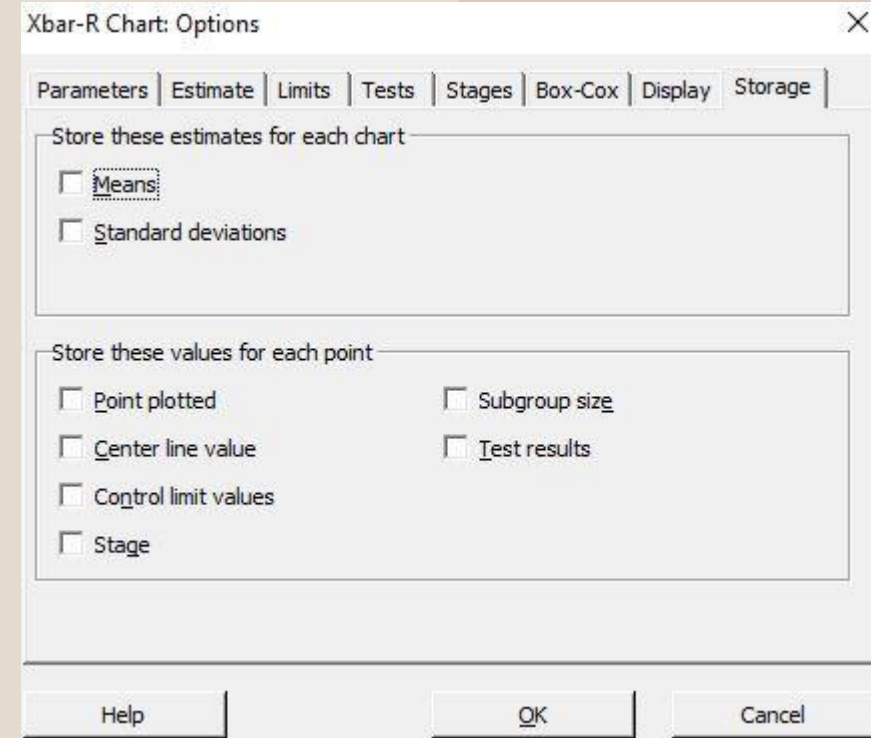
☐ Each segment corresponds to a stage (if chart has stages)

Other

☒ Display control chart results in output tab

☐ Display control limit / center line labels for all stages

Help OK Cancel



Xbar-R Chart: Options

Parameters | Estimate | Limits | Tests | Stages | Box-Cox | Display | Storage

Store these estimates for each chart

☐ Means

☐ Standard deviations

Store these values for each point

☐ Point plotted

☐ Subgroup size

☐ Center line value

☐ Test results

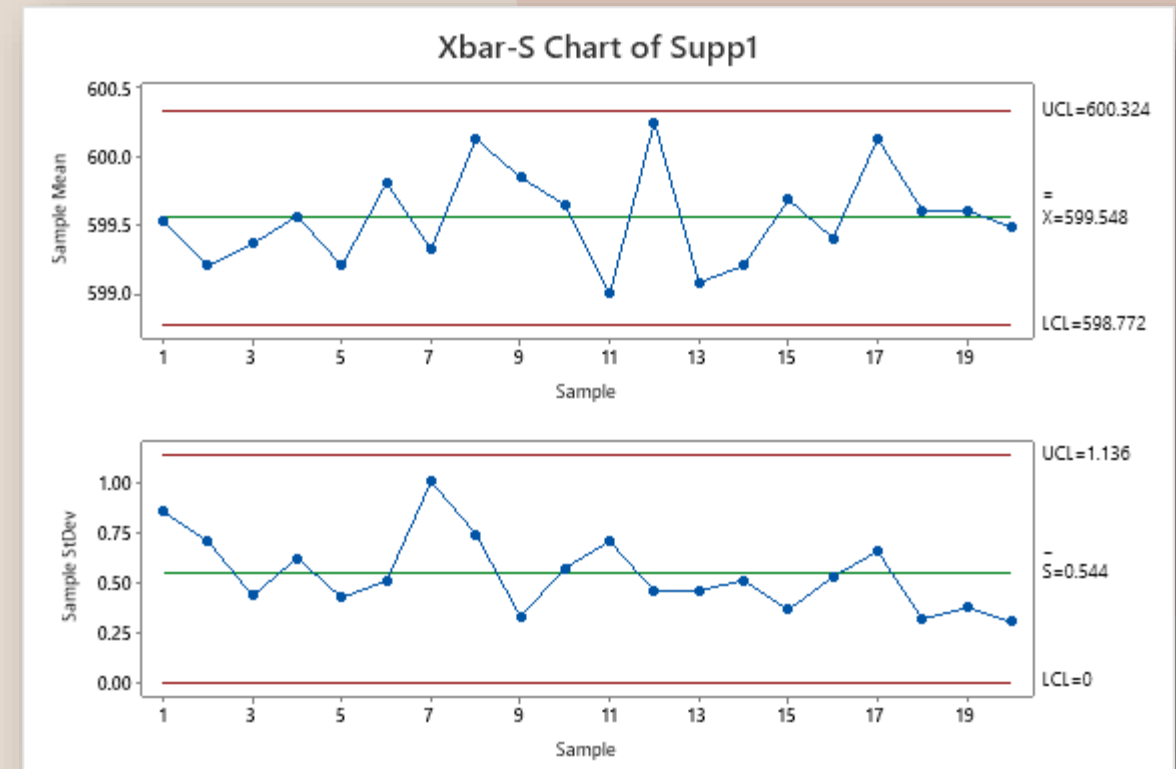
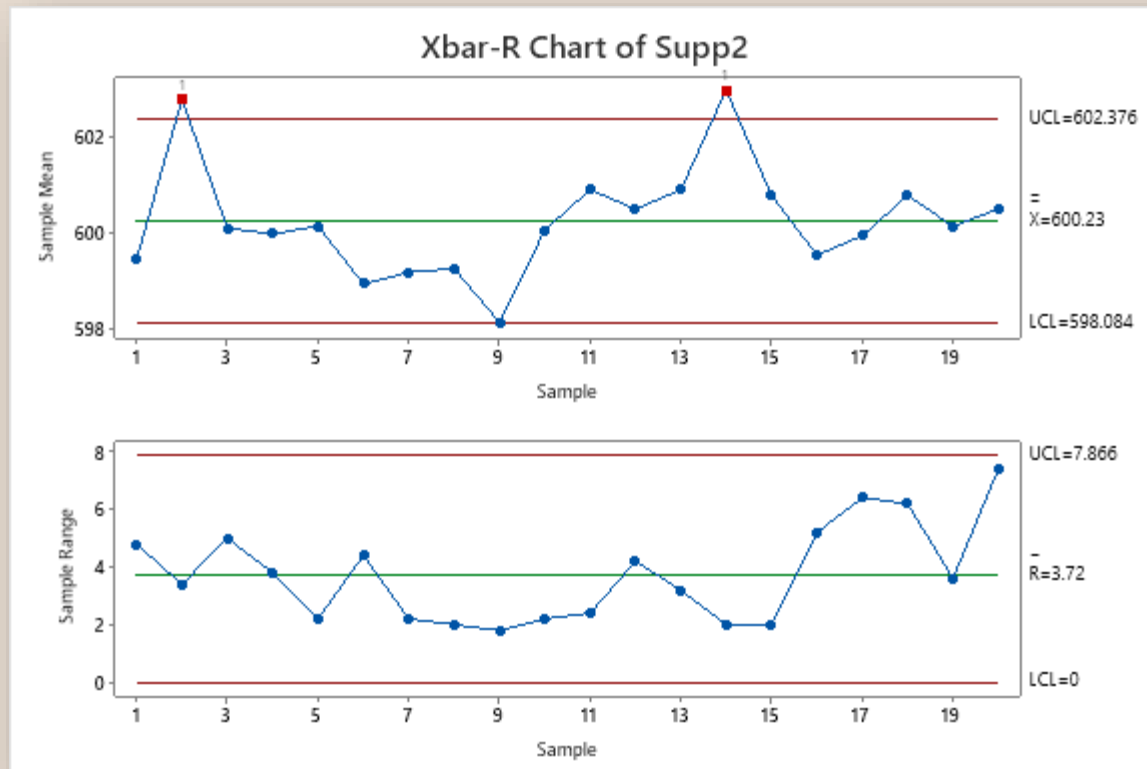
☐ Control limit values

☐ Stage

Help OK Cancel

نمودار Xbar-R/S

Stat → Control Charts → Variables Charts for Subgroup → Xbar-R/S



I-MR نمودار

Stat → Control Charts → Variables Charts for Individuals → I-MR

Individuals-Moving Range Chart

Variables: Weight

Scale... Labels... Multiple Graphs... Data Options... I-MR Options...

Select Help OK Cancel

Individuals-Moving Range Chart: Options

Parameters Estimate Limits Tests Stages Box-Cox Display Storage

Omit the following subgroups when estimating parameters (eg, 3 12:15)

Method for estimating standard deviation

Subgroup size = 1

☒ Average moving range

☐ Median moving range

Length of moving range: 2

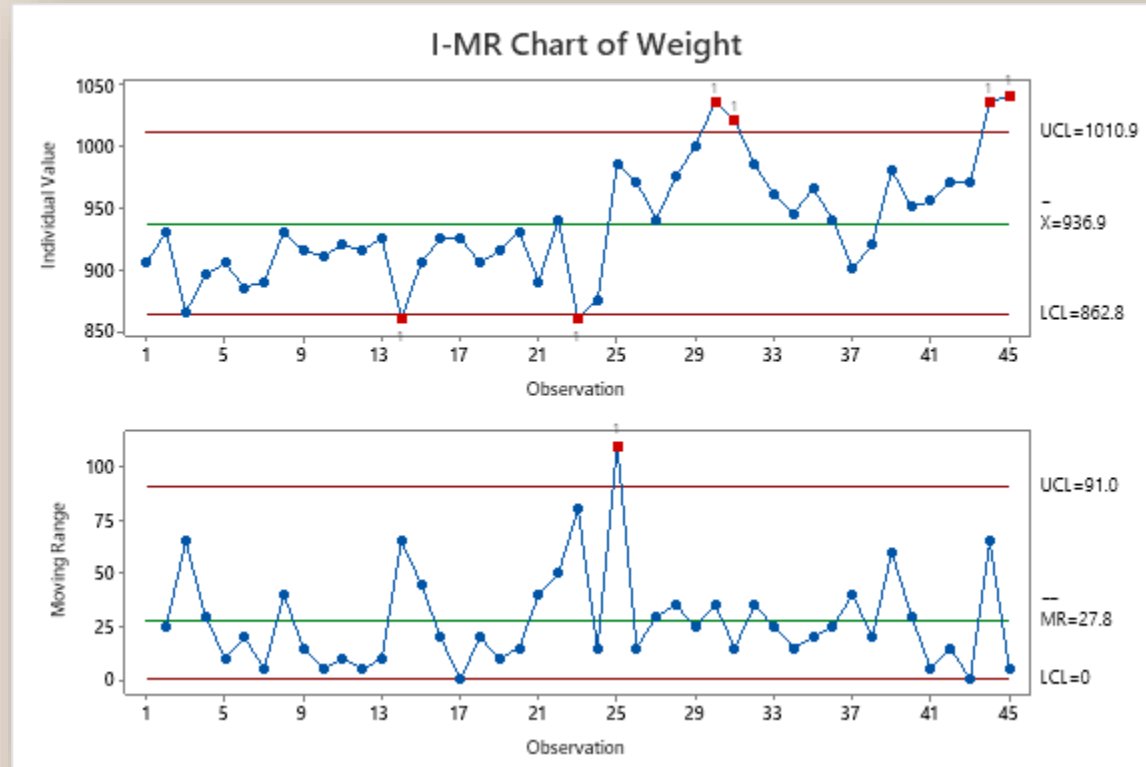
☐ Use Nelson estimate

Help OK Cancel

| | C1-T | C2-T | C3 | C4 | C5 | C6 | C7 | C8 |
|---|---------|-----------------|--------|----------|-------|--------|---------|---------|
| | Damage | Defects | Counts | Faults | Shift | Weight | Rejects | Sampled |
| 1 | Scratch | Missing Screws | 274 | -0.22435 | 1 | 905 | 20 | 98 |
| 2 | Scratch | Missing Clips | 59 | 0.29532 | 1 | 930 | 18 | 104 |
| 3 | Bend | Defective Housi | 19 | 0.35517 | 1 | 865 | 14 | 97 |
| 4 | Chip | Leaky Gasket | 43 | -0.25060 | 1 | 895 | 16 | 99 |
| 5 | Dent | Scrap | 4 | 0.04660 | 1 | 905 | 13 | 97 |
| 6 | Scratch | Unconnected Wir | 8 | -0.01963 | 2 | 885 | 29 | 102 |
| 7 | Chip | Missing Studs | 6 | 0.12111 | 2 | 890 | 21 | 104 |

I-MR نمودار

Stat → Control Charts → Variables Charts for Individuals → I-MR



Test Results for I Chart of Weight

TEST 1. One point more than 3.00 standard deviations from center line.
Test Failed at points: 14, 23, 30, 31, 44, 45

Test Results for MR Chart of Weight

TEST 1. One point more than 3.00 standard deviations from center line.
Test Failed at points: 25

نمودار P/NP

Stat → Control Charts → Attributes Charts → P/NP

P Chart

Variables:

Rejects

Subgroup sizes: Sampled
(enter a number or column containing the sizes)

Scale... Labels... Multiple Graphs... Data Options... P Chart Options...

Select

Help OK Cancel

P Chart: Data Options

Subset

Include or Exclude

☒ Specify which rows to include

☐ Specify which rows to exclude

Specify Which Rows To Include

☒ All rows

☐ Rows that match Condition...

☐ Brushed rows

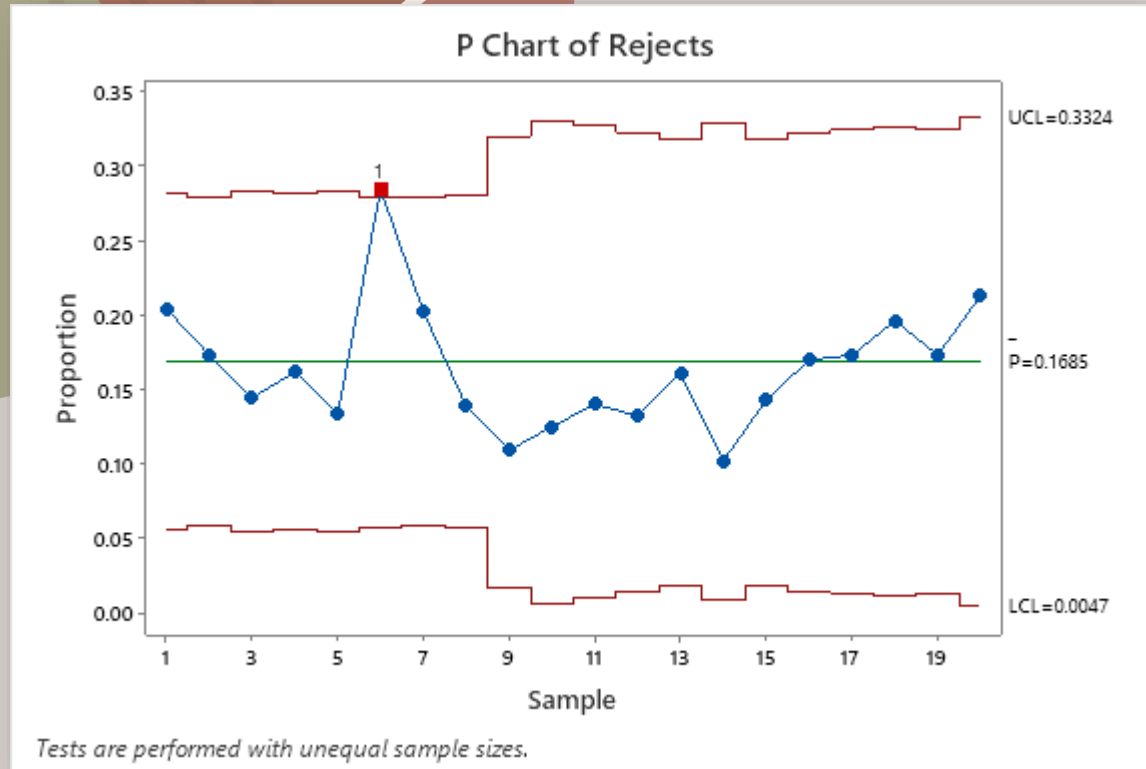
☐ Row numbers:

☐ Leave gaps for excluded points

Help OK Cancel

نمودار P/NP

Stat → Control Charts → Attributes Charts → P/NP



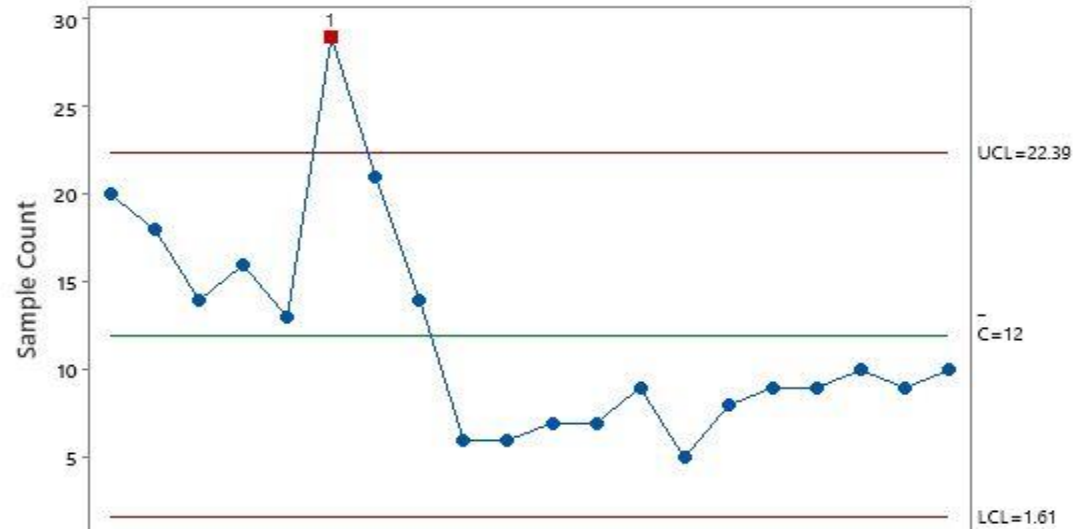
Test Results for P Chart of Rejects

TEST 1. One point more than 3.00 standard deviations from center line.
Test Failed at points: 6

نمودار C/U

Stat → Control Charts → Attributes Charts → C/U

C Chart of Rejects



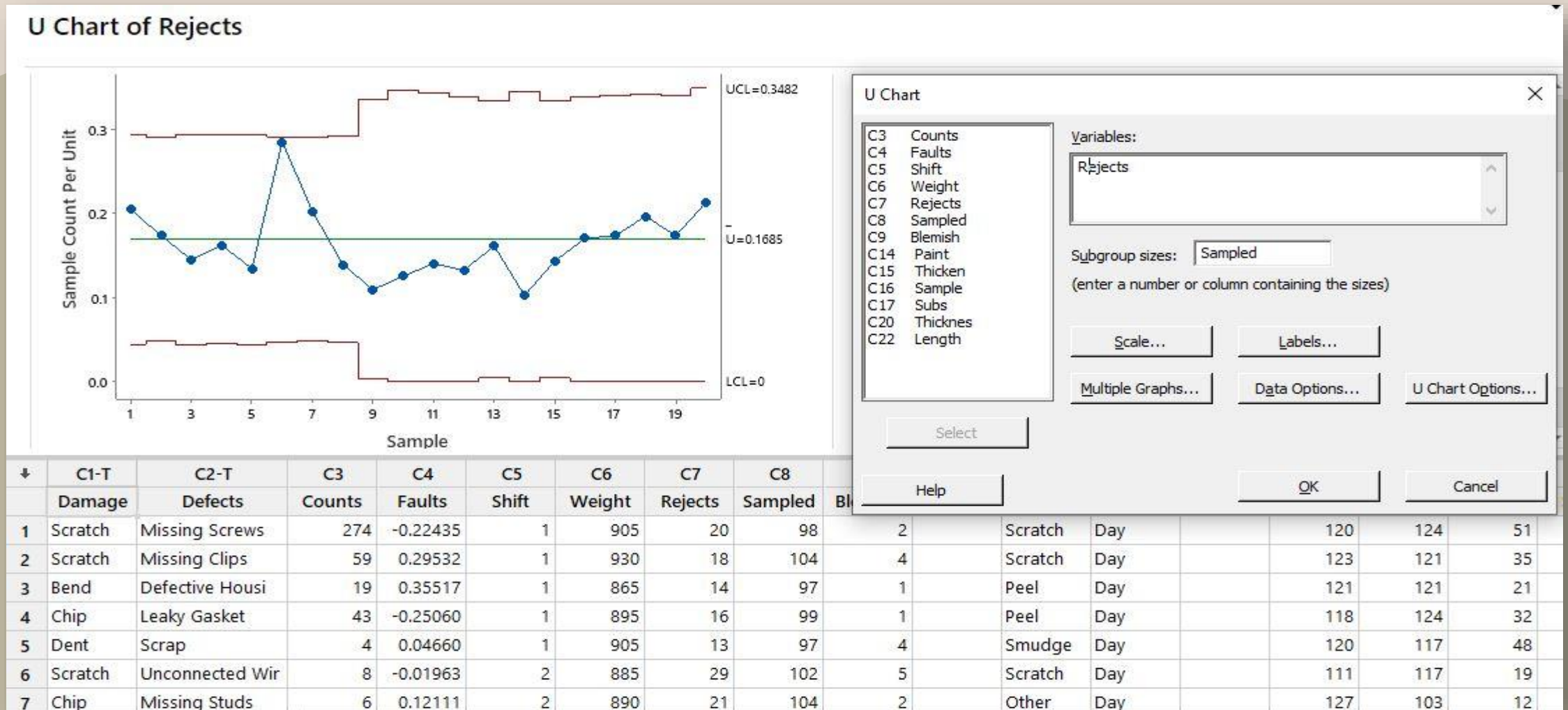
C Chart

Variables: Rejects

| ↓ | C1-T | C2-T | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11-T | C12-T | C13 | C14 | C15 | C16 |
|---|---------|-----------------|--------|----------|-------|--------|---------|---------|---------|-----|---------|--------|-----|-------|---------|--------|
| | Damage | Defects | Counts | Faults | Shift | Weight | Rejects | Sampled | Blemish | | Flaws | Period | | Paint | Thicken | Sample |
| 1 | Scratch | Missing Screws | 274 | -0.22435 | 1 | 905 | 20 | 98 | 2 | | Scratch | Day | | 120 | 124 | 51 |
| 2 | Scratch | Missing Clips | 59 | 0.29532 | 1 | 930 | 18 | 104 | 4 | | Scratch | Day | | 123 | 121 | 35 |
| 3 | Bend | Defective Housi | 19 | 0.35517 | 1 | 865 | 14 | 97 | 1 | | Peel | Day | | 121 | 121 | 21 |
| 4 | Chip | Leaky Gasket | 43 | -0.25060 | 1 | 895 | 16 | 99 | 1 | | Peel | Day | | 118 | 124 | 32 |
| 5 | Dent | Scrap | 4 | 0.04660 | 1 | 905 | 13 | 97 | 4 | | Smudge | Day | | 120 | 117 | 48 |
| 6 | Scratch | Unconnected Wir | 8 | -0.01963 | 2 | 885 | 29 | 102 | 5 | | Scratch | Day | | 111 | 117 | 19 |
| 7 | Chip | Missing Studs | 6 | 0.12111 | 2 | 890 | 21 | 104 | 2 | | Other | Day | | 127 | 103 | 12 |

نمودار C/U

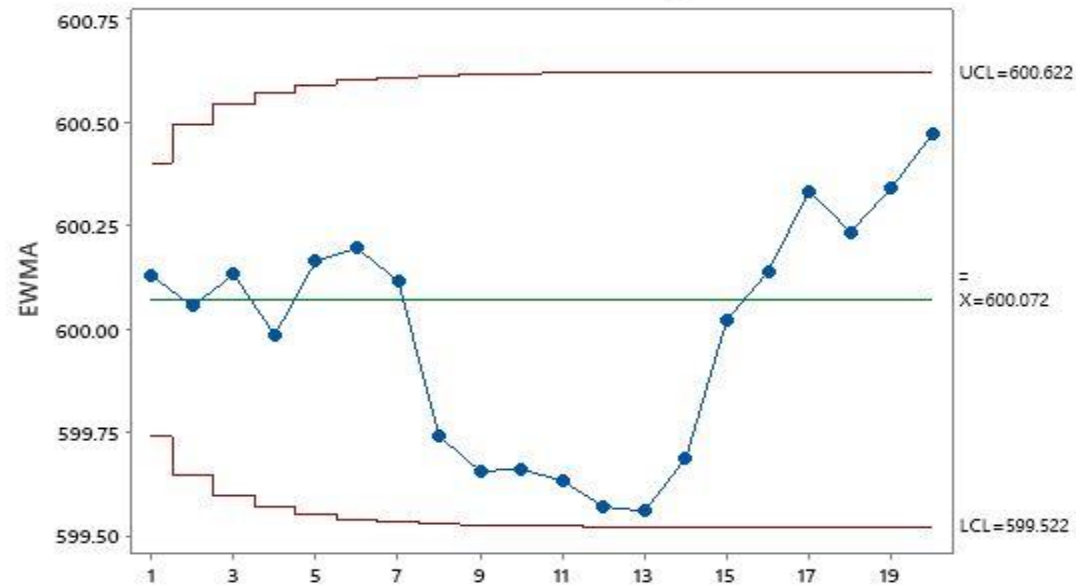
Stat → Control Charts → Attributes Charts → C/U



نمودار EWMA

Stat → Control Charts → Time-Weighted Charts → EWMA

EWMA Chart of Length



EWMA Chart

All observations for a chart are in one column:

Subgroup sizes: (enter a number or ID column)

Weight of EWMA:

Scale... Labels... Multiple Graphs... Data Options... EWMA Options...

Select

Help OK Cancel

| ↓ | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 | C16 | C17 |
|---|--------|-------|-------|------------|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| | Length | Supp1 | Supp2 | Subject_Id | | | | | | | | | | | | | |
| 1 | 601.4 | 598.0 | 601.6 | 1 | | | | | | | | | | | | | |
| 2 | 601.6 | 599.8 | 600.4 | 1 | | | | | | | | | | | | | |
| 3 | 598.0 | 600.0 | 598.4 | 1 | | | | | | | | | | | | | |
| 4 | 601.4 | 599.8 | 600.0 | 1 | | | | | | | | | | | | | |
| 5 | 599.4 | 600.0 | 596.8 | 1 | | | | | | | | | | | | | |

CUSUM نمودار

Stat → Control Charts → Time-Weighted Charts → CUSUM

CUSUM Chart

All observations for a chart are in one column: ▼

Length ▲ ▼

Subgroup sizes: 'Subject_Id' (enter a number or ID column)

Target: 600

Scale... Labels...

Multiple Graphs... Data Options... CUSUM Options...

Select

Help OK Cancel

CUSUM Chart: Options

Parameters | Estimate | Plan/Type | Stages | Box-Cox | Display | Storage

Type of CUSUM

- ☒ Tabular
- ☐ V-mask

☐ Use FIR

Number of standard deviations: 2.0

☐ Reset after each signal

CUSUM Plan

h: 4.0

k: 0.5

When subgroup sizes are unequal, calculate control limits/V-mask

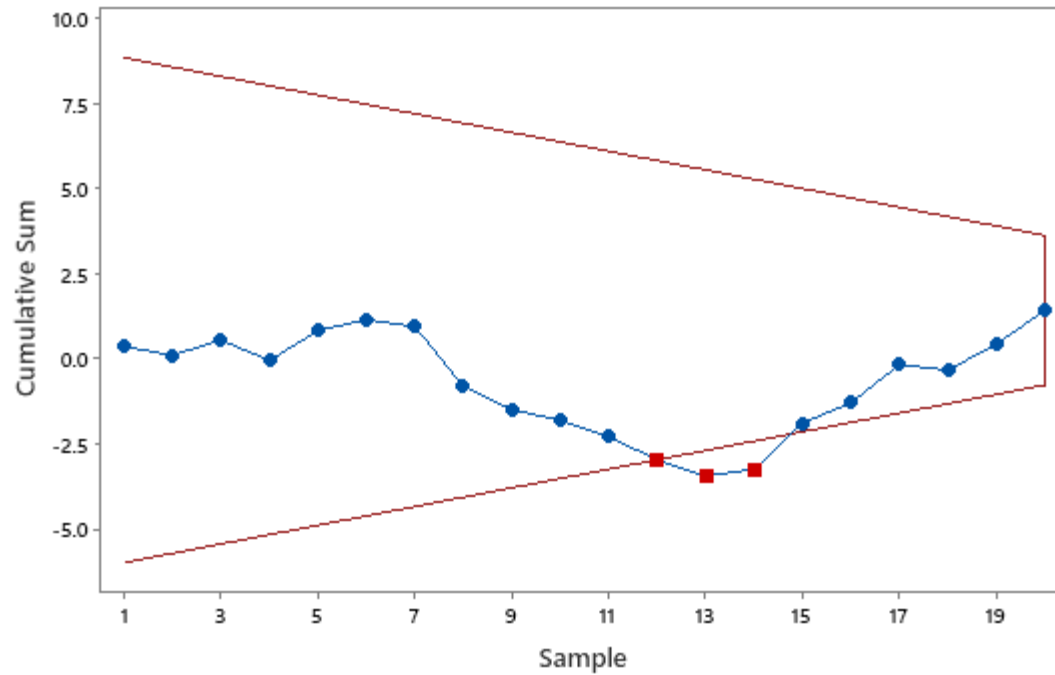
- ☒ Using actual sizes of the subgroups
- ☐ Assuming all subgroups have size: 1

Help OK Cancel

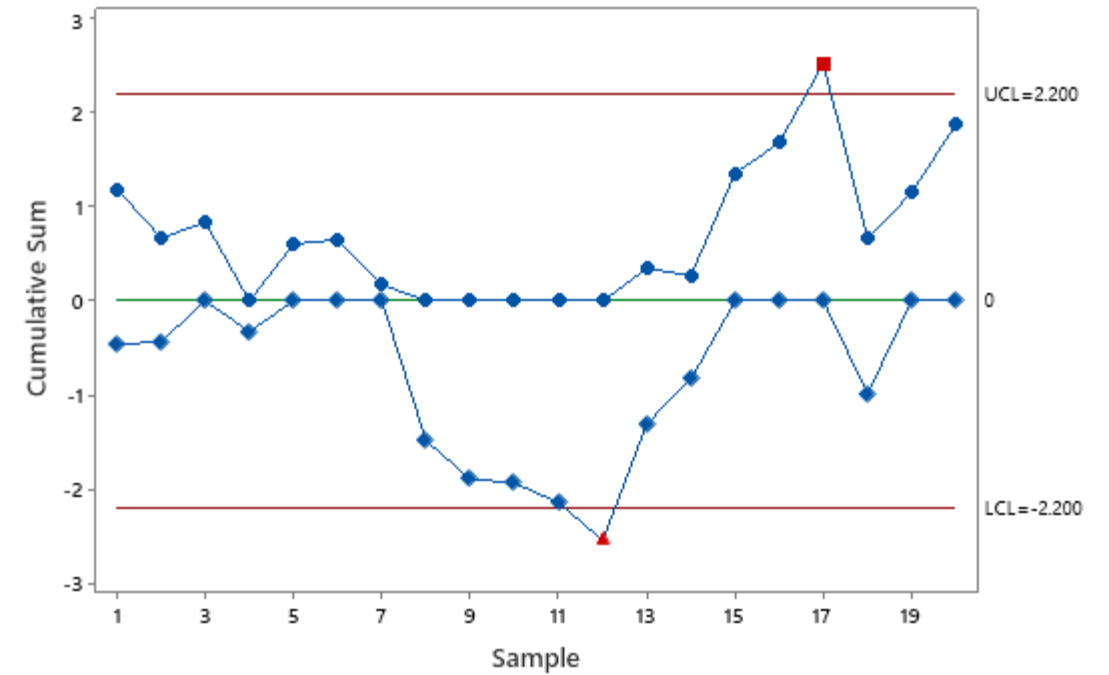
CUSUM نمودار

Stat → Control Charts → Time-Weighted Charts → CUSUM

Vmask Chart of Length



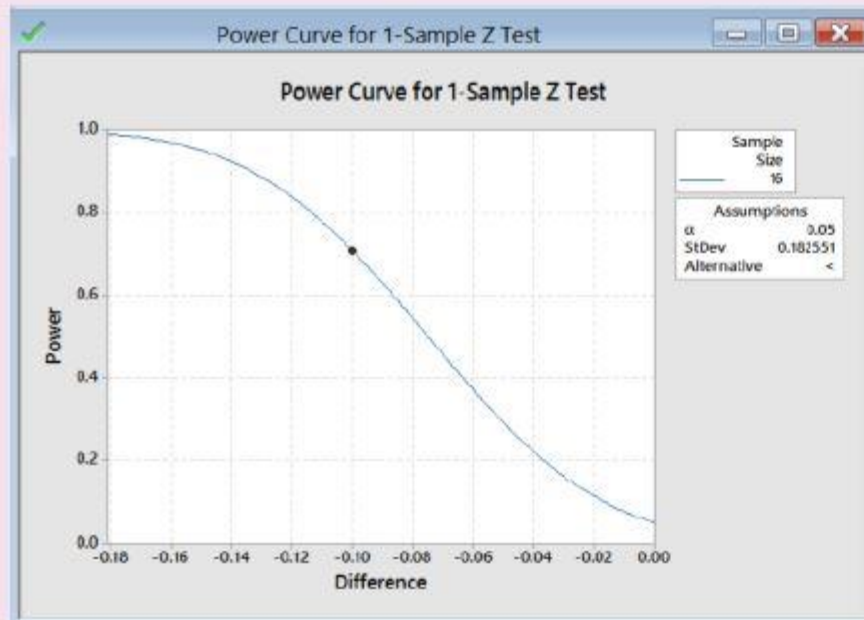
CUSUM Chart of Length



منحنی OC

مثال: اگر میانگین فرآیند یک دهم کاهش یابد، اندازه‌ی نمونه چقدر باشد تا این تغییر با احتمال ۷۰٪ با اولین نمونه‌گیری کشف شود؟

Stat → Power and Sample Size → 1-Sample Z



Power and Sample Size for 1-Sample Z

Specify values for any two of the following:

Sample sizes:

Differences:

Power values:

Standard deviation:

Options... Graph...

Help OK Cancel



thank you

علی فدایی تفرشی

alift2971377@gmail.com