Report

- Industrial Engineering Department -

(Statistical) Quality Control

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By

Renad Hajed Algethami

Lesson 5:

Control chart for variables (Xbar-R), case of n >1

Methods and their steps:

Method 1) using the Minitab:

1- I transferred data from Excel to Minitab, which is 5 groups, each group contains 25 samples.

2- Arranging all the sample sets, line by line, in one column through the (Data) icon, then (Stack), and then (Rows). After that, I selected the columns for all the five data, and I specified the column in which all the data will be arranged. After arranging the sample groups in one column, I have a number of samples = 125.

3-I drew the control charts by pressing the (stat) icon, then (control charts), then (variables charts for subgroups), then select (xbar-R), then select the column in step 2, and specify in (subgroup sizes) 5 groups.

Method 2) Using Excel:

1- We find (x-bar), which is the average of each sample of the samples, an example of calculating the first sample using the Excel function: {=AVERAGE(B2:F2)} = 1, then we drag the cell to the last sample cell.

2- We find (Double X bar), which is the average of all the averages of the samples, represented by (LC-X bar). Calculate (LC-X bar) using Excel function {=AVERAGE(G2:G26)}=1.424.

3- We find the range (R) of each sample. To calculate the range of the first sample using Excel function {=MAX(B2:F2)-MIN(B2:F2)}= 25, then we drag the cell to the last sample cell.

4- We find the average of all the range of samples, represented by (LC-R). Calculate (LC-R) using Excel function {=AVERAGE(J2:J26)} = 24.68 .

5- Calculate (UCL-X bar) & (UCL-R) using the following rules:
(UCL-X bar) = Double X bar + A2*(R bar) using Excel function {=G27+(0.577*J27)} = 15.6644
(UCL-R) = D4*(R bar) using Excel function { =2.114*J27} = 52.17352

6- Calculate (LCL-X bar) & (LCL-R) using the following rules:
(LCL-X bar) = Double X bar – A2*(R bar) using Excel function {=G27-(0.577*J27)} = -12.8164
(LCL-R) = D3*(R bar) using Excel function { =0*J27} = 0

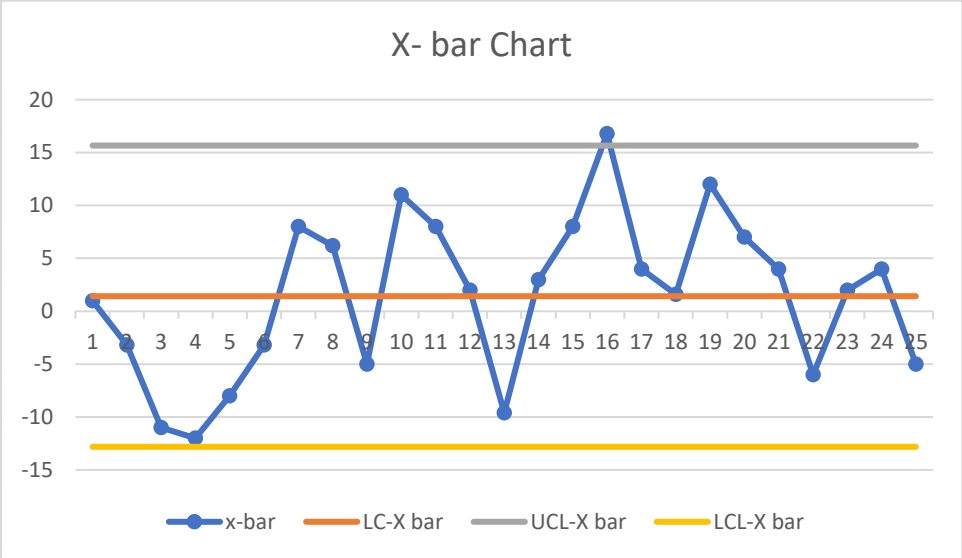
7- We fix the value of (CL-X bar) to a column that extends from 1-25 cells. We do the same for (UCL-X bar), (LCL-X bar), (LC-R), (UCL-R) and (LCL-R).

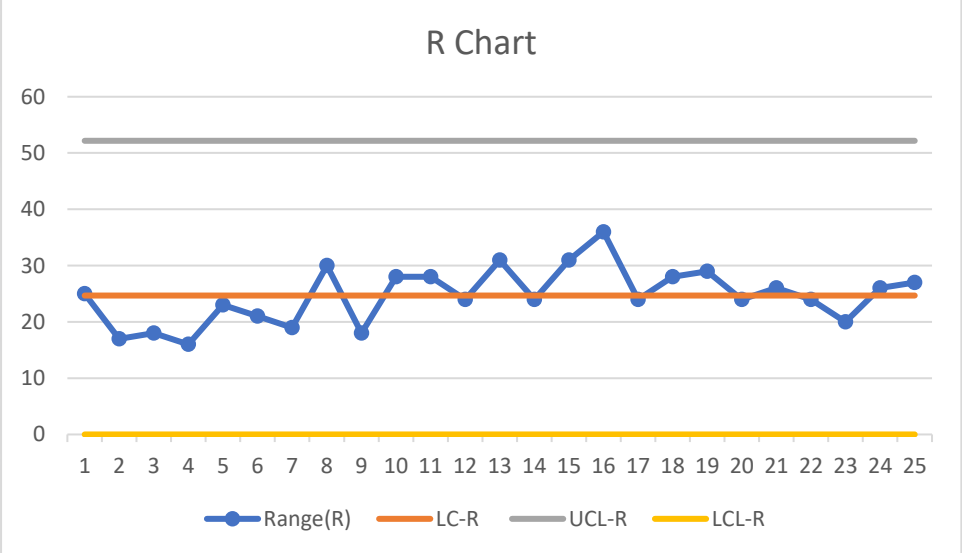
8- We define an x-bar, a CL-X bar, a UCL-X bar, and an LCL-X bar. From the (Insert Chart) icon in Excel we choose (Line), thus it will appear to us (X-bar Chart)

9- We define (R), (LC-R), (UCL-R) and (LCL-R) column. From the (Insert Chart) icon in Excel we choose (Line), so it will appear to us (R-Chart).

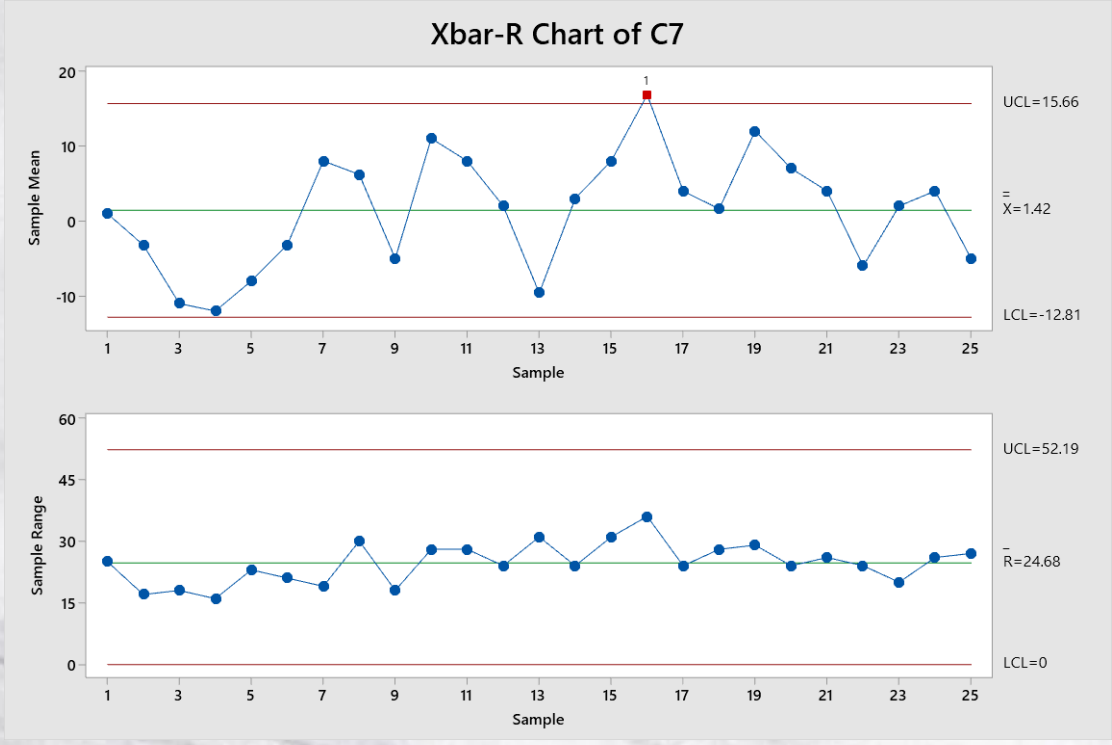
The result:

1) Using Excel:





2) using the Minitab:



Conclusion:

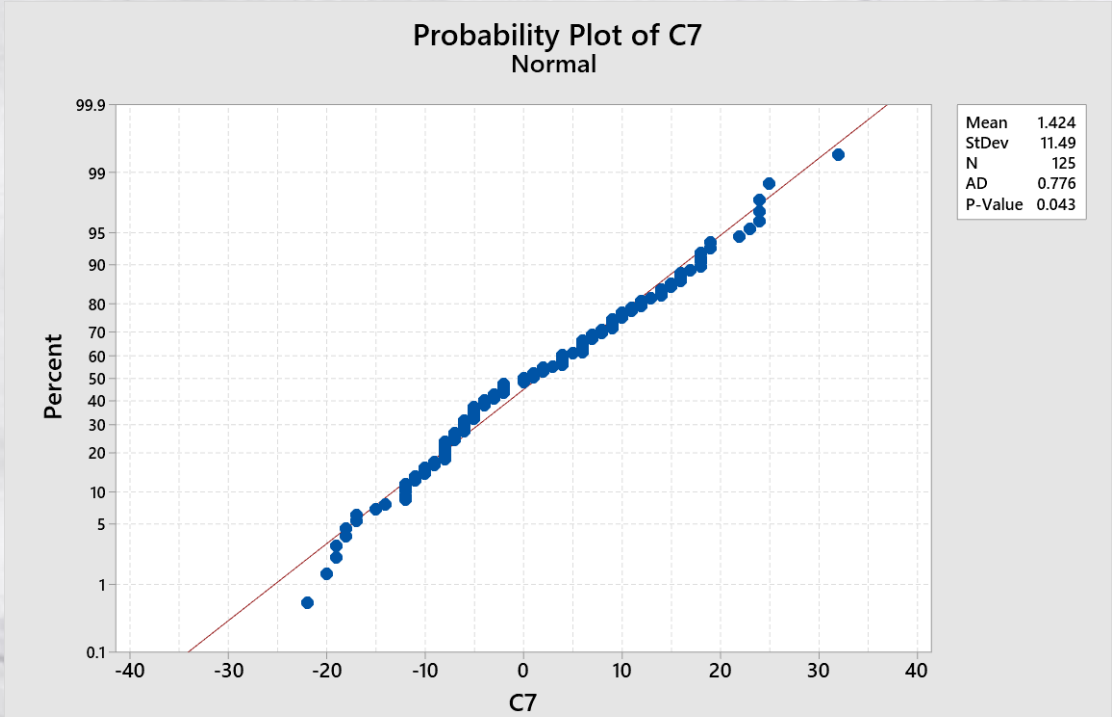
When I used the minitab and when I used Excel, the same control chart appeared.

We can deduce from the X-bar chart, representing the central tendency that some values were very close to the lower control limit such as sample number 4, and that all samples were under control and did not exceed the upper control limit and lower control limit. Except for sample number 16, it exceeded the upper limit, so we can say that it is out of control. Thus this means that the process is not stable.

We can deduce from the Range (R) chart, representing dispersion (variance) that all samples were under control and did not exceed the upper control limit and lower control limit, but almost all data values were close to the center line. Thus this means that the process is stable.

In conclusion, we conclude from the previous data that there is more stability in dispersion than the central tendency and that all data in dispersion are under control.

Normality test: (P-Value)



Conclusion:

P-Value = 0.043 <0.05 So we conclude that the data are not of a normal distribution. Therefore, we reject the null hypothesis H0 with a significance level of 5% and a confidence level of 95%. Thus the alternative hypothesis Ha is valid.

Lesson 6:

Control chart for variables (Xbar-S), case of n >1

Methods and their steps:

Method 1) using the Minitab:

1- I transferred data from Excel to Minitab, which is 5 groups, each group contains 25 samples.

2- Arranging all the sample sets, line by line, in one column through the (Data) icon, then (Stack), and then (Rows). After that, I selected the columns for all the five data, and I specified the column in which all the data will be arranged. After arranging the sample groups in one column, I have a number of samples is 125.

3-I drew the control charts by pressing the (stat) icon, then (control charts), then (variables charts for subgroups), then select (Xbar-S), then select the column in step 2, and specify in (subgroup sizes) is 5 groups.

Method 2) Using Excel:

1- We find (x-bar), which is the average of each sample of the samples, an example of calculating the first sample using the Excel function: {=AVERAGE(B2:F2)} = 1, then we drag the cell to the last sample cell.

2- We find (Double X bar), which is the average of all the averages of the samples, represented by (LC-X bar). Calculate (LC-X bar) using Excel function {=AVERAGE(G2:G26)}=1.424

3- We find the standard deviation (S) of each sample. To calculate the standard deviation of the first sample using Excel function {=STDEV.S(B2:F2)}= 9.97497, then we drag the cell to the last sample cell.

4- We find the average of all the standard deviation of samples, represented by (LC-S). Calculate (LC-S) using Excel function {=AVERAGE(H2:H26)} = 9.59126

5- Calculate (UCL-X bar) & (UCL-S) using the following rules:
(UCL-X bar) = Double X bar + A3*(S bar) using Excel function {=G27+(1.427*H27)}= 15.11073
(UCL-S) = B4*(S bar) using Excel function {=H27*2.089} = 20.0361

6- Calculate (LCL-X bar) & (LCL-S) using the following rules:
(LCL-X bar) = Double X bar – A3*(S bar) using Excel function {=G27-(1.427*H27)}= -12.26273
(LCL-S) = B3*(S bar) using Excel function {=H27*0} = 0

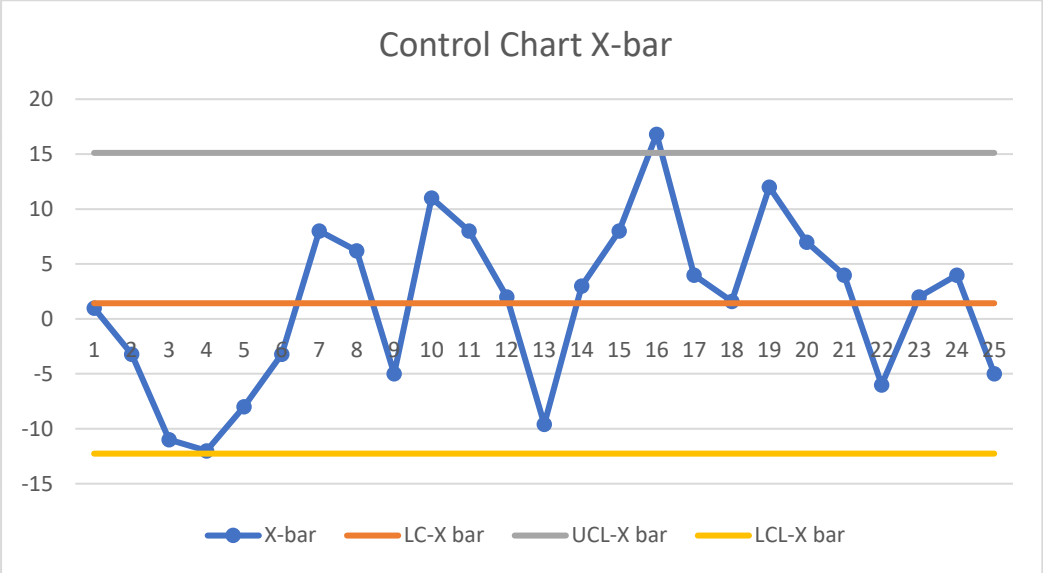
7- We fix the value of (CL-X bar) to a column that extends from 1-25 cells. We do the same for (UCL-X bar), (LCL-X bar), (LC-S), (UCL-S) and (LCL-S).

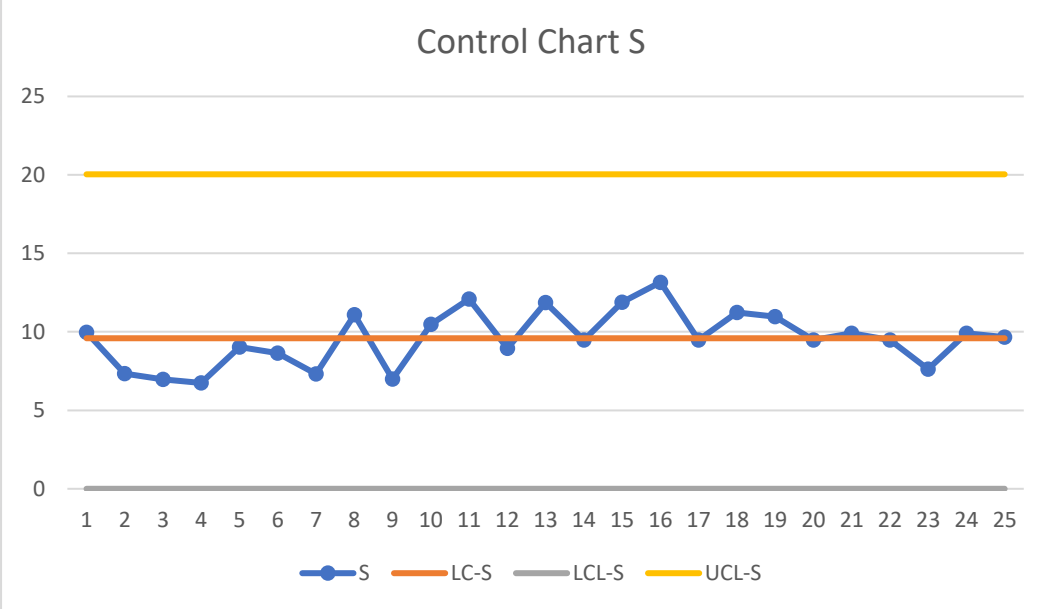
8- We define an x-bar, a CL-X bar, a UCL-X bar, and an LCL-X bar. From the (Insert Chart) icon in Excel we choose (Line), thus it will appear to us (X-bar Chart)

9- We define (S), (LC-S), (UCL-S) and (LCL-S) column. From the (Insert Chart) icon in Excel we choose (Line), so it will appear to us (S-Chart).

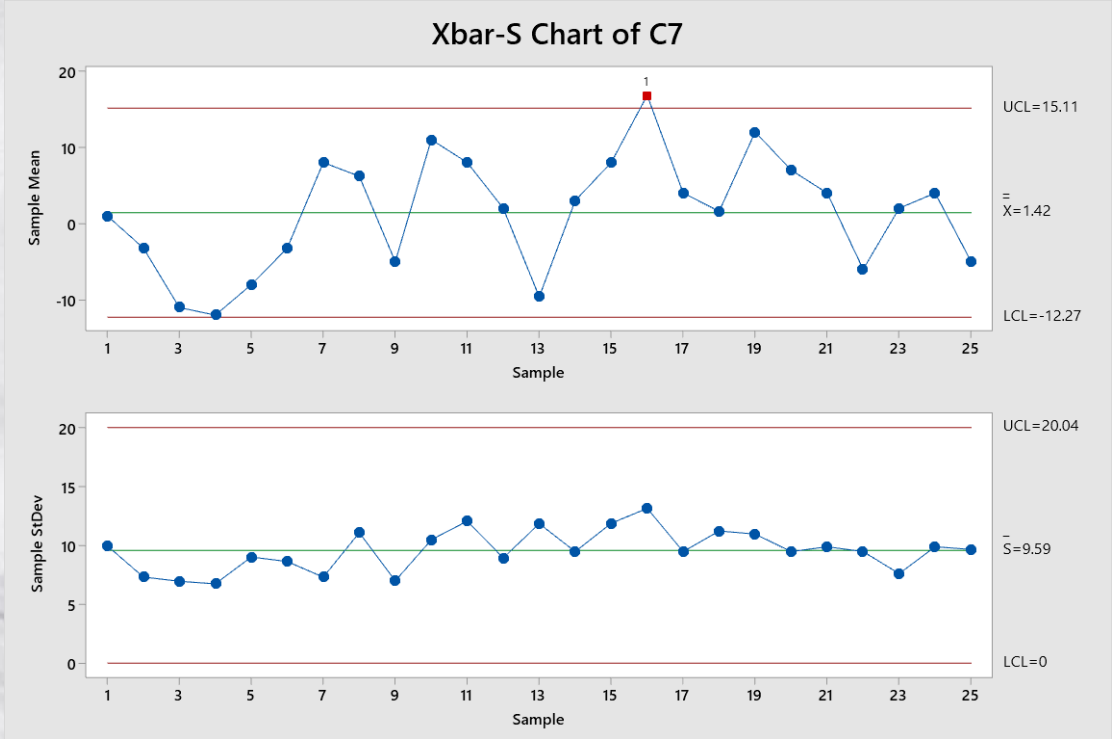
The result:

1) Using Excel:





2) using the Minitab:



Conclusion:

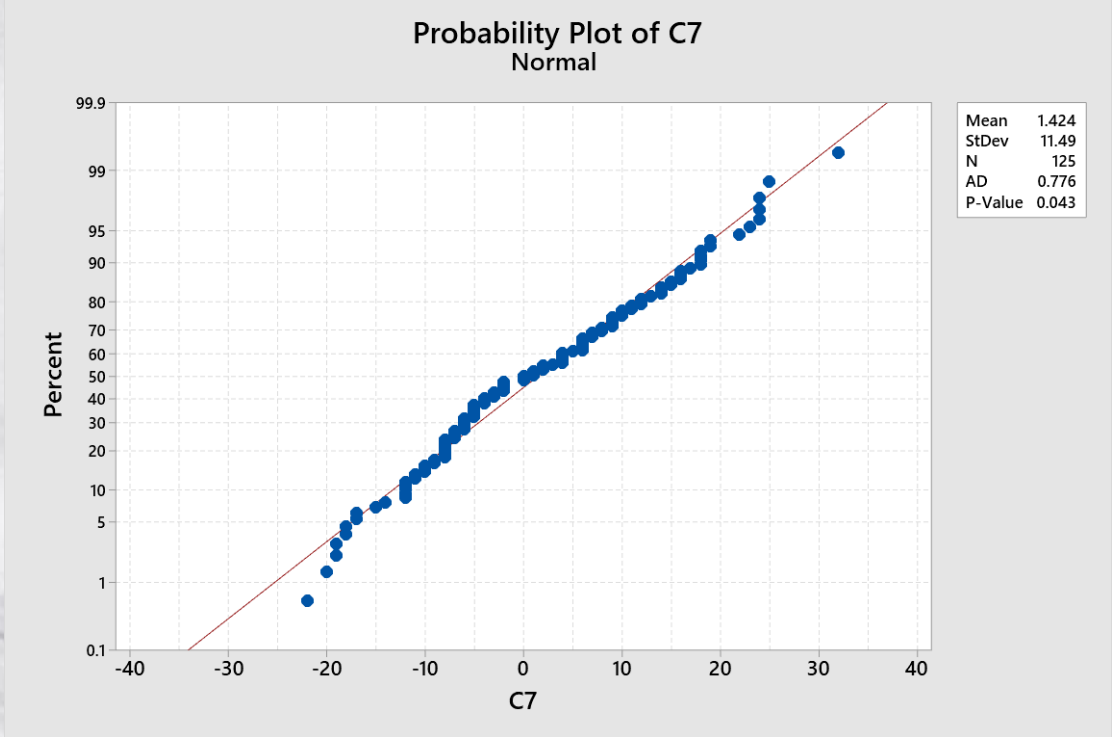
When I used the minitab and when I used Excel, the same control chart appeared.

We can deduce from the X-bar chart, representing the central tendency that some values were very close to the control minimum such as sample number 4, and that all samples were under control and did not exceed the upper control limit and lower control limit. Except for sample number 16, it exceeded the upper limit, so we can say that it is out of control. Thus this means that the process is not stable.

We can deduce from the standard deviation (S) chart, representing dispersion (variance) that all values were under control and did not exceed the upper control limit and lower control limit, but almost all data values were close to the center line. Thus this means that the process is stable.

In conclusion, we conclude from the previous data that there is greater stability in the dispersion of the data from each other as compared to the central tendency in the average (X-bar) and that all the data in the dispersion are under control.

Normality test: (P-Value)



Conclusion:

P-Value = 0.043 <0.05 So we conclude that the data are not of a normal distribution. Therefore, we reject the null hypothesis H0 with a significance level of 5% and a confidence level of 95%. Thus the alternative hypothesis Ha is valid.

Lesson 7:

Control chart for variables (I-MR), case of n = 1

Methods and their steps:

Method 1) using Minitab:

1- I transferred the X column data from Excel to Minitab, which is data containing subgroup n=1 and number of samples =30.

2- I drew the control charts by clicking on the stat icon, then (control charts), then (variables charts for individuals), then I chose the (I-MR) icon, after that I selected the column that contains the data. It was not asked here that we specify the size of the sample in (I-MR) because its size is one.

Method 2) Using Excel:

1- We find (X bar), which is the average of all the 30 values of X, and it represents (CL-X bar). To calculate the average of the data using an Excel function: {=AVERAGE(B2:B31)}= 25.4666667

2- We find (MR) for all X values except for n = 1, so we start to calculate (MR) from n= 2. Calculate it using an Excel function: {=ABS(B3-B2)}= 11, then drag this cell to n=30

3- We find (MR bar), which is the average of all 29 values of (MR), and it represents (CL- MR). Calculate it using an Excel function: {=AVERAGE(C3:C31)}= 14.4482759

4- We calculate (UCL-X) & (UCL-MR) using the following rules:
(UCL-X)= X bar + 3*MR bar/d2 using Excel function {=(B33+3*C33/1.128)}= 63.8929
(UCL-MR) = D4*(MR bar) using Excel function {=3.267*C33}= 47.2025172

5- We calculate (LCL-X) & (LCL-MR) using the following rules:
(LCL-X)= X bar - 3*MR bar/d2 using Excel function {=(B33-3*C33/1.128)}= -12.95959
(LCL-MR) = D3*(MR bar) using Excel function {=0*C33}= 0

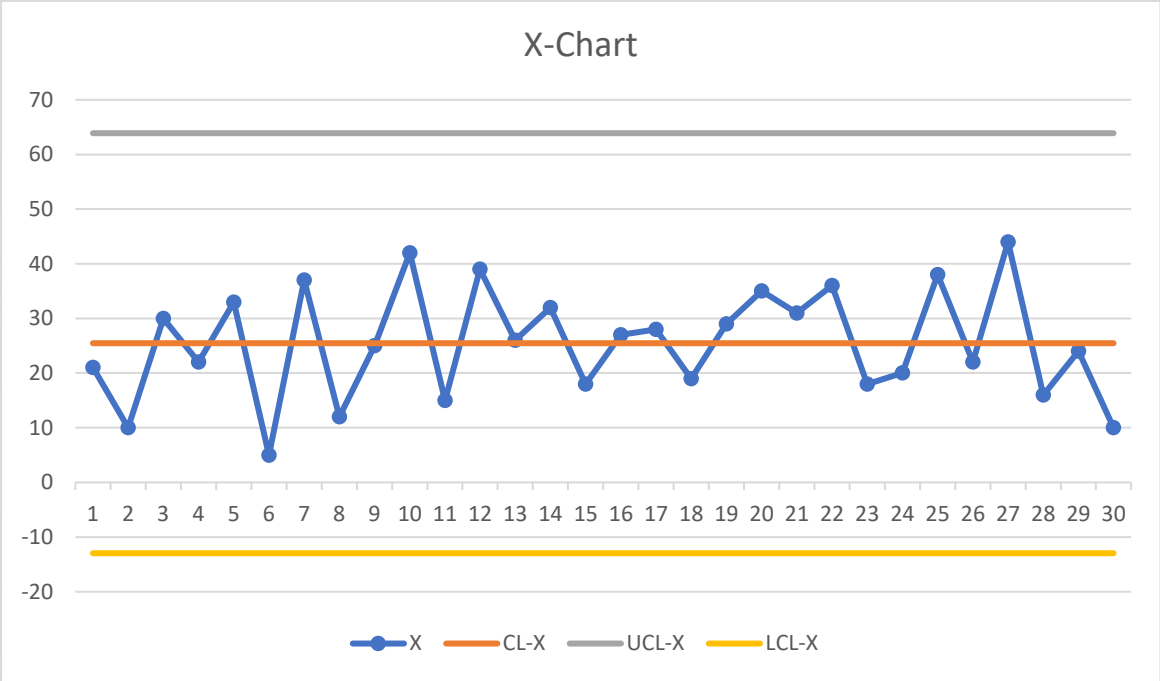
6\- We install the value of (CL-X) in a column that extends from 1-30 cells. We do the same for (UCL-X), (LCL-X), (LC-MR), (UCL-MR) and (LCL-MR).

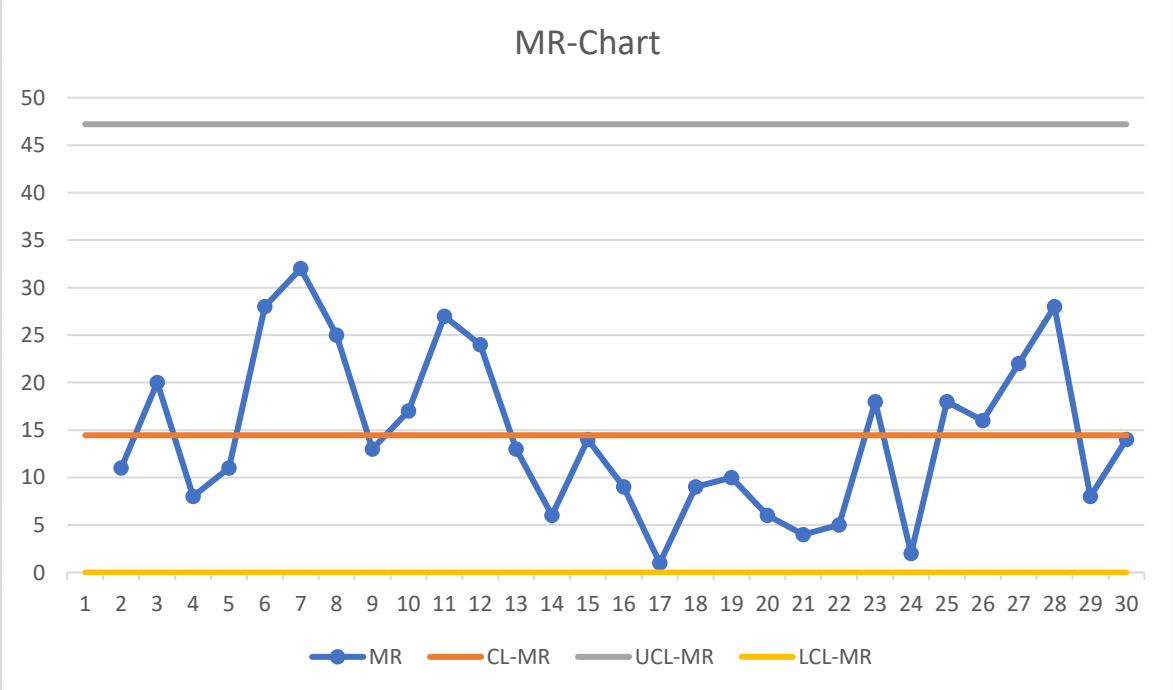
7- We define (X) column (CL-X) column (UCL-X) and (LCL-X) column. From the (Insert Chart) icon in Excel we choose (Line), thus it will appear to us (X-Chart)

8- We define (MR), (LC-MR), (UCL-MR) and (LCL-MR) column. From the (Insert Chart) icon in Excel, we choose (Line), so the (MR-Chart) will appear.

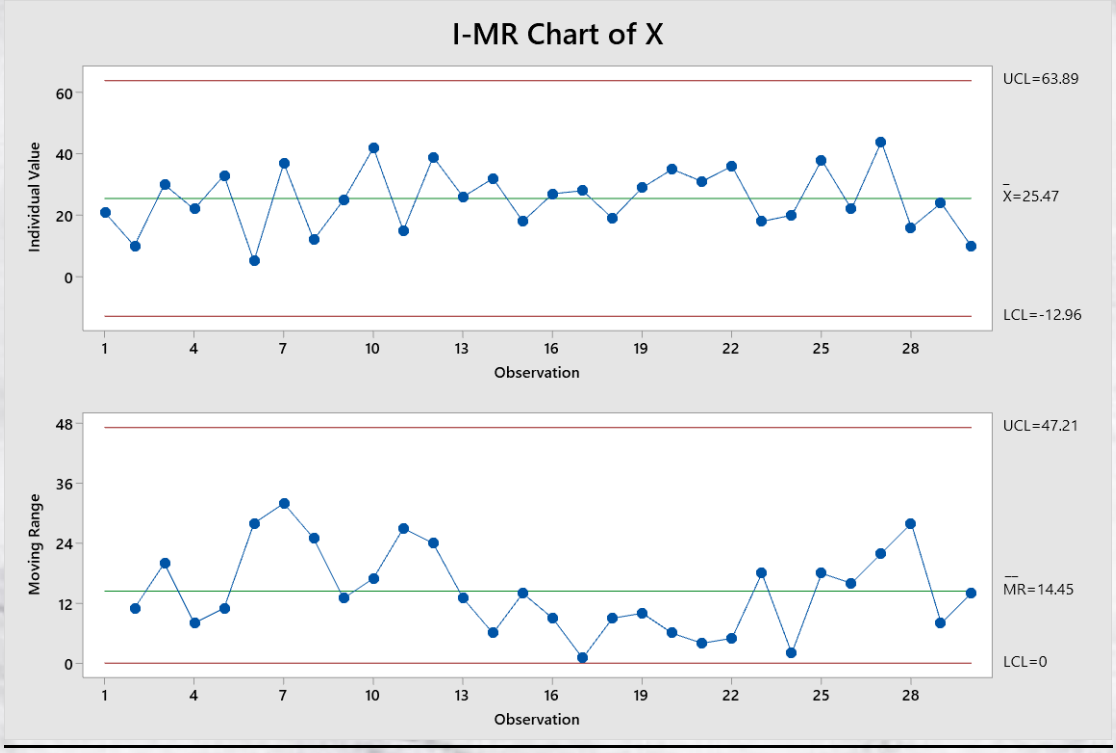
The result:

1) Using Excel:





2) using the Minitab:



Conclusion:

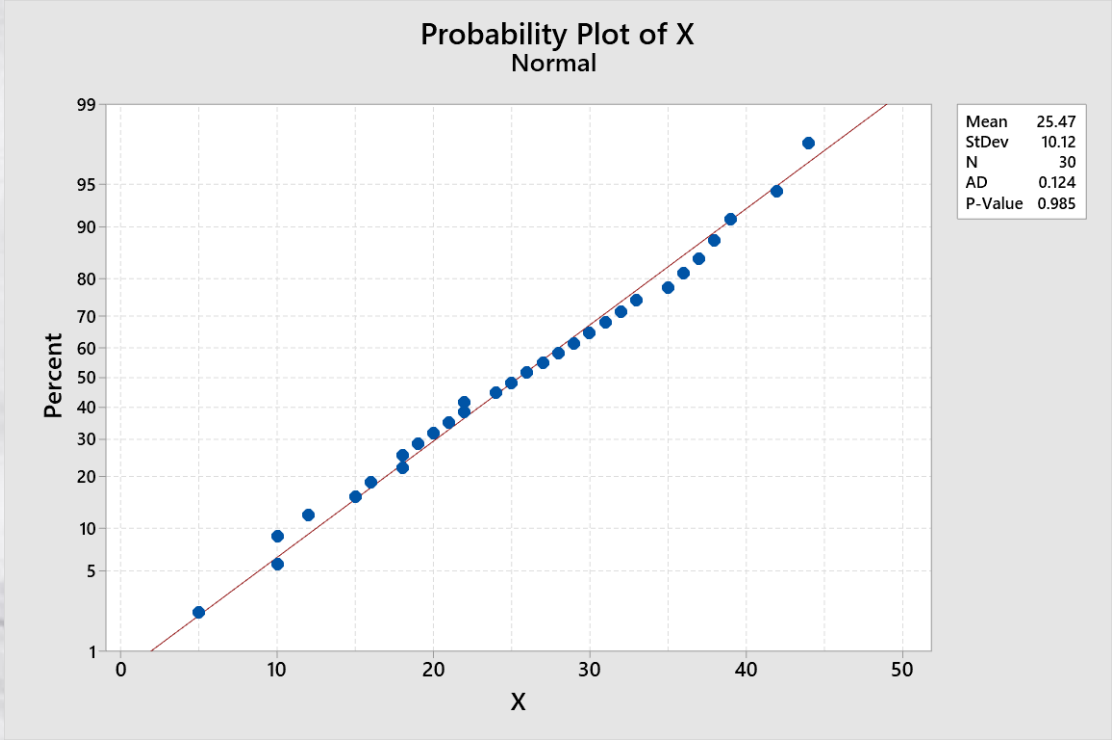
When I used Minitab and when I used Excel, the same control chart appeared.

We can deduce from the X- chart representing the central tendency (mean of the individual data) that all sample values of size is 30 were under control and did not exceed the upper and lower control limits. Thus this means that the process is stable.

We can conclude from the MR- chart which represents the variation (moving range) that the extent of dispersion of the sample of size is 30 was under control and did not exceed the upper and lower control limits. Thus this means that the process is stable.

In conclusion, we conclude from the previous data for the sample of size 30 that it is under control, and that there is stability in the dispersion of the data about each other, and stability in its centering around a certain value.

Normality test: (P-Value)



Conclusion:

P-Value = 0.985> 0.05, so we conclude that the data are of a normal distribution. Therefore, we accept the null hypothesis H0 with a significance level of 5% and a confidence level of 95%. Thus the alternative hypothesis Ha is false.

Lesson 8:

Control chart for variables (I-MR) without data normality

Methods and their steps:

Method 1) using Minitab:

1- I transferred the DV(Hr) column data from Excel to Minitab, which is data containing subgroup n=1 and number of samples =150.

2- I drew the control charts by clicking on the stat icon, then (control charts), then (variables charts for individuals), then I chose the (I-MR) icon, after that I selected the column that contains the data. It was not asked here that we specify the size of the sample in (I-MR) because its size is one.

Method 2) Using Excel:

1- We find (DV bar), which is the average of all the 150 values of DV, and it represents (CL- DV bar). To calculate the average of the data using an Excel function: {=AVERAGE(B2:B151)}= 28.4339

2- We find (MR) for all X values except for n = 1, so we start to calculate (MR) from n= 2. Calculate it using an Excel function: {=ABS(B3-B2)}= 2.3805, then drag this cell to n=150

3- We find (MR bar), which is the average of all 149 values of (MR), and it represents (CL- MR). Calculate it using an Excel function: {=AVERAGE(C3:C151)}= 4.69166

4- We calculate (UCL-DV) & (UCL-MR) using the following rules:
(UCL-DV)= DV bar + 3*MR bar/d2 using Excel function {=(B153+3*C153/1.128)}= 40.91179
(UCL-MR) = D4*(MR bar) using Excel function {=3.267*C153}= 15.32765

5- We calculate (LCL-X) & (LCL-MR) using the following rules:
(LCL-DV)= DV bar - 3*MR bar/d2 using Excel function {=(B153-3*C153/1.128)}= 15.95615
(LCL-MR) = D3*(MR bar) using Excel function {=0*C153}= 0

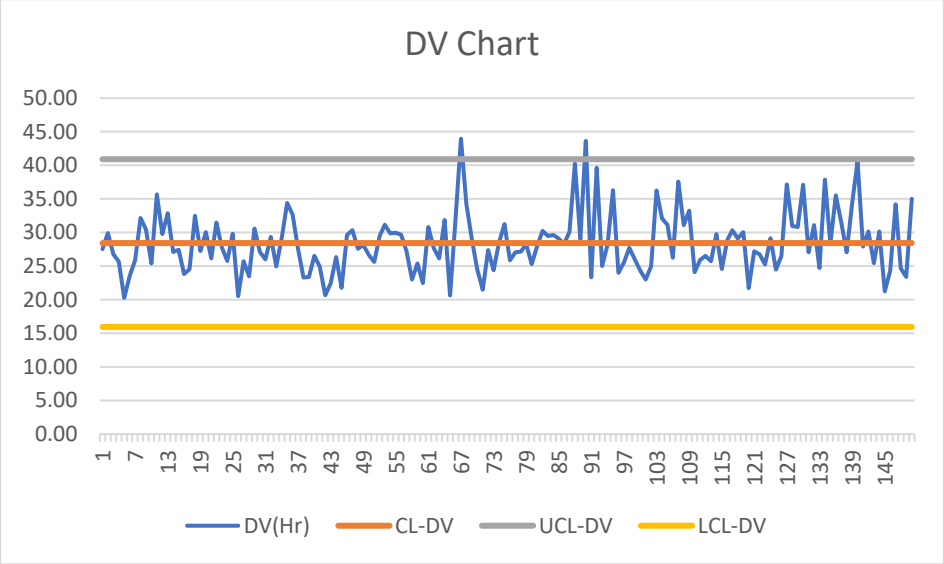
6- We install the value of (CL-DV) in a column that extends from 1-150 cells. We do the same for (UCL-DV), (LCL-DV), (LC-MR), (UCL-MR) and (LCL-MR).

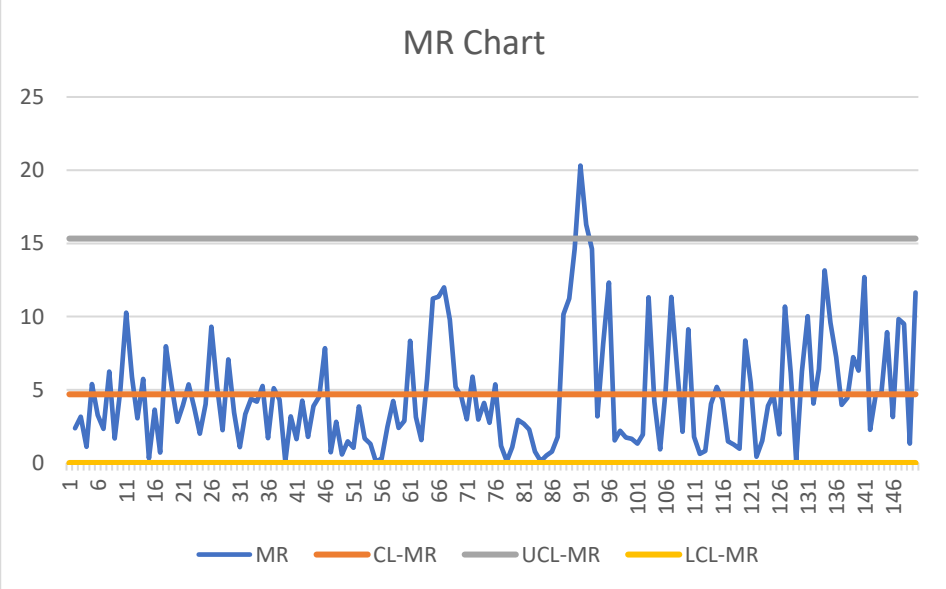
7- We define (DV) column (CL-DV) column (UCL-DV) and (LCL-DV) column. From the (Insert Chart) icon in Excel we choose (Line), thus it will appear to us (DV-Chart)

8- We define (MR), (LC-MR), (UCL-MR) and (LCL-MR) column. From the (Insert Chart) icon in Excel, we choose (Line), so the (MR-Chart) will appear.

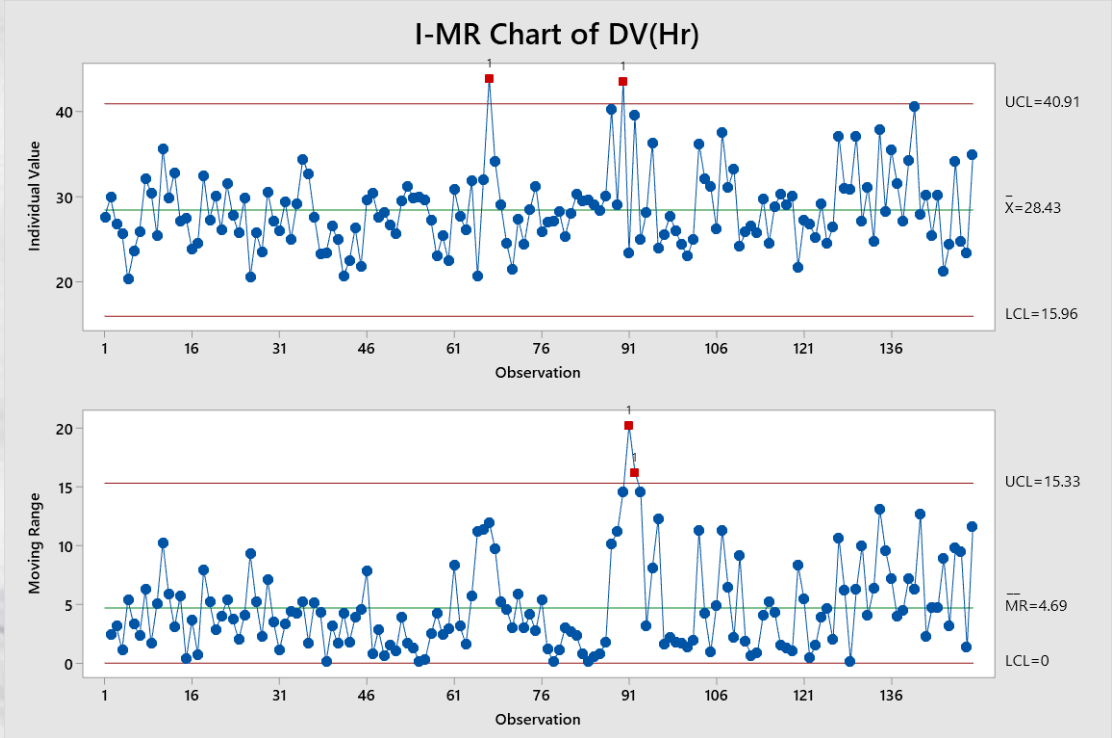
The result:

1) Using Excel:





2) using the Minitab:



Conclusion:

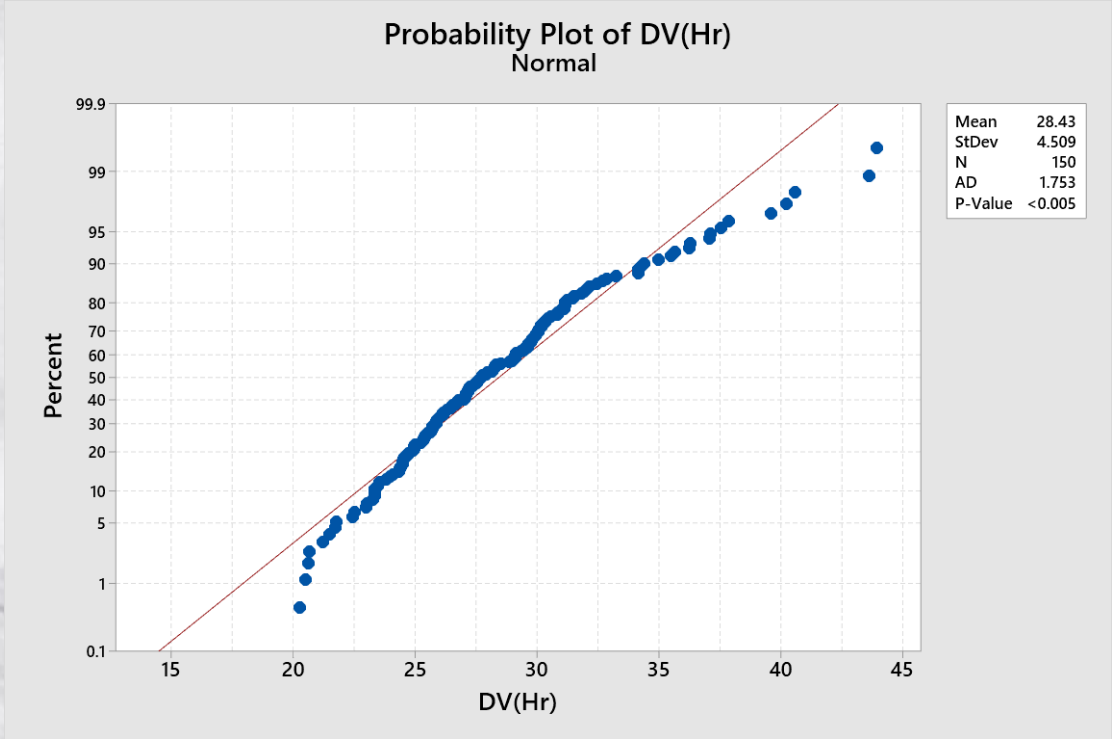
When I used Minitab and when I used Excel, the same control chart appeared.

We can conclude from the DV chart representing the central trend, (average of individual data) that all sample values of size is 150 are under control and did not exceed the upper and lower control limits. With the exception of samples 67 and 90 where they exceeded the upper control limit, so we can say that they are out of control. Thus this means that the process is not stable.

We can conclude from the MR chart representing variance (moving range) that the extent of sample dispersion with size is 150 was under control and did not exceed the upper and lower control limits. With the exception of samples 91 and 92, they exceeded the upper control limit, so we can say that they are out of control. Thus this means that the process is not stable.

In conclusion, we conclude from the previous data for the sample of size 150 that it is out of control, and that there is no stability in the dispersion of the values from each other, and that it is also not centered around a specific value.

Normality test: (P-Value)



Conclusion:

P-Value = 0.005 < 0.05 So we conclude that the data are not of a normal distribution. Therefore, we reject the null hypothesis H0 with a significance level of 5% and a confidence level of 95%. Thus the alternative hypothesis Ha is valid.