7315 - Systems Quality Engineering

Assignment 7 & 8

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Question 1 (modified version of Question 7.3 in the textbook) – 0.5 points total

The following table contains data on examination of medical insurance claims. Every day 50 claims were examined.

Day	**Nonconforming**
1	0
2	3
3	4
4	6
5	5
6	2
7	8
8	9
9	4

10	2
11	6
12	4
13	8
14	0
15	7
16	20
17	6
18	1
19	5
20	7

Set up the fraction nonconforming control chart for this process:

A. Calculate the upper control limit and lower control limit for this chart. Show the formulas and calculations (0.25 points).

   As we see in L11- slide 7, we can find the p' and CL by

   Size, n=50

   No of samples, m=20

   $P' = (\Sigma D_i / (m)(n))$

   $= 107 / (20)(50)$

= 107/1000

P' = 0.107

Now, 3 sigma limits for a non-conforming chart is calculated by

UCL = p’ + 3 √p’(1-p')/n

= 0.107 + 3 √0.107(0.893)/50

= 0.107 + 3(0.0437)

= 0.2381

LCL = p’ - 3 √p’(1-p')/n

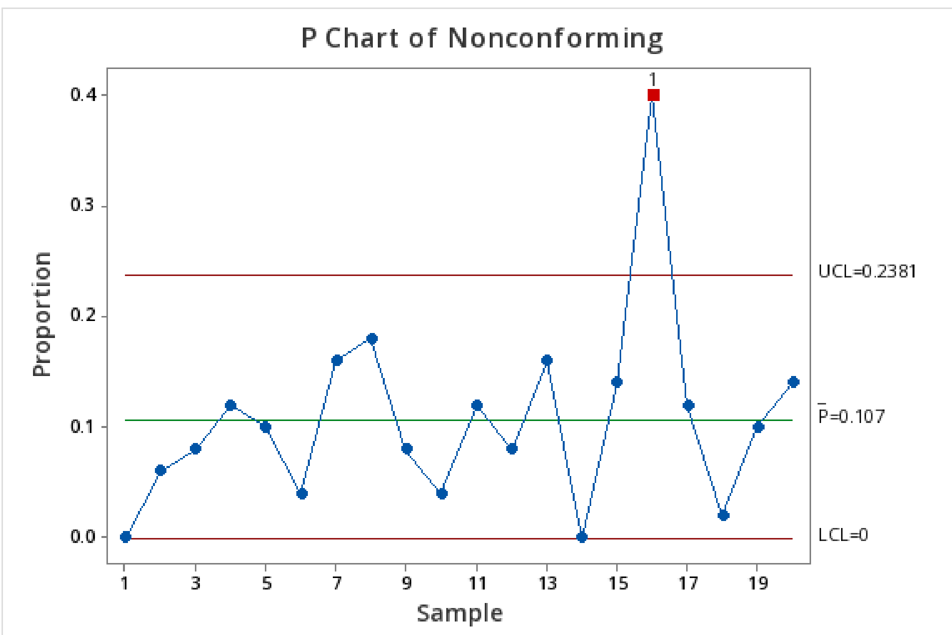
= 0.107 - 3 √0.107(0.893)/50

= 0.107 - 3(0.0437)

= -0.0241

Since LCL is less than zero, we assume zero and consider only UCL for the chart.

B. Plot this chart on Minitab or Excel. Is the process in statistical control? Why / why not? (0.25 points)



The process is **not in a state of statistical control** as **point-16 lies outside** the control limit (UCL). This is sufficient evidence to conclude so.

Question 2 (modified version of Question 7.37 in the textbook) – 0.5 points total

The number of nonconformities found on final inspection of a tape deck is shown in table below:

Deck	**Nonconformities**
2412	0
2413	1
2414	1
2415	0
2416	2
2417	1
2418	1
2419	3
2420	2
2421	1
2422	0
2423	3
2424	2
2425	5
2426	1
2427	2
2428	1
2429	1

Set up a control chart for nonconformities this process:

A. Calculate the upper control limit and lower control limit for this chart. Show the formulas and calculations (0.25 points).

   As we see in L11- slide 34, we can find the c' and CL by

   $c' = (\Sigma D_i / (m))$

   $= 27 / 18$

   $c' = 1.5$

   Now, 3 sigma limits for a non-conforming chart is calculated by

   $UCL = c' + 3\sqrt{c}$

   $= 1.5 + 3\sqrt{1.5}$

   $= 1.5 + 3(1.2247)$

   $= 5.174$

LCL = c’ - 3 √c

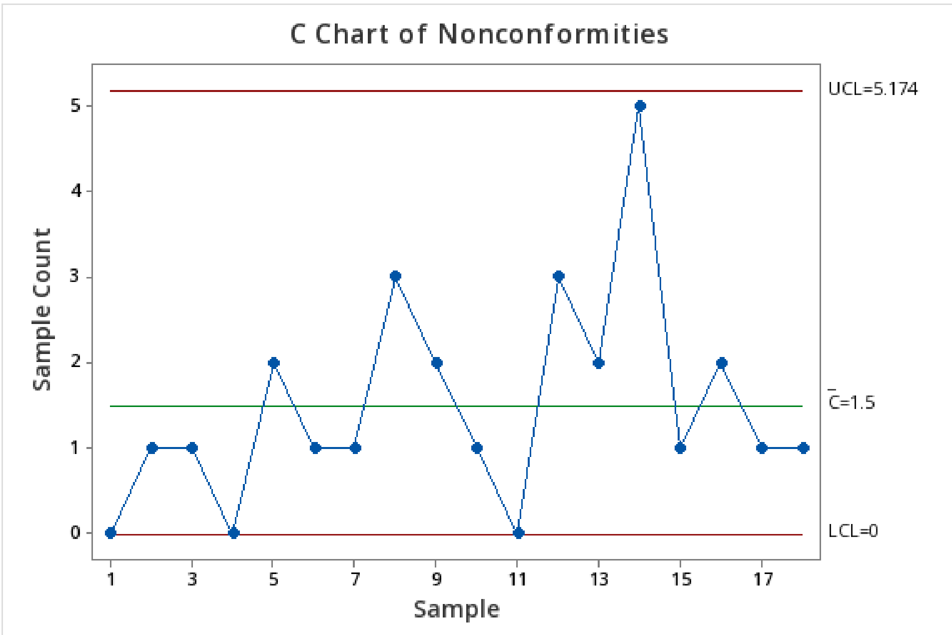
= 1.5 - 3 √1.5

= 1.5 - 3(1.2247)

= -2.1741

Since LCL is less than zero, we assume zero and consider only UCL for the chart.

B. Plot this chart on Minitab or Excel. Is the process in statistical control? Why / why not? (0.25 points)



The process can be said to be **in statistical control** as it does not deter from any significant test methods while checking for not in control points.

Question 3 (modified version of Question 7.39 in the textbook) – 0.5 points total

An automobile manufacturer wishes to monitor the number of nonconformities in a subassembly area producing manual transmissions. The inspection unit is defined as four transmissions, and data from 16 samples (each of size 4) are shown in table below.

Sample	**Nonconformities**
1	1
2	3
3	2
4	1

5	0
6	2
7	1
8	5
9	2
10	1
11	0
12	2
13	1
14	1
15	2
16	3

Set up a control chart for nonconformities per unit for this process:

A. Calculate the upper control limit and lower control limit for this chart. Show the formulas and calculations (0.25 points).

As we see in L11- slide 43, we can find the u' and CL by

Size, n=4

No of samples, m=16

u'= (ΣD_i / (m) (n))

[Calculating u=D/n for each value and then doing Σu_i/m yields same result. Therefore, we calculate it directly with above method.]

= 27 / (16) (4)

u' = 0.4219

Now, 3 sigma limits for a non-conforming chart is calculated by

UCL = u' + 3 $\sqrt{(u'/n)}$

= 0.4219 + 3 $\sqrt{(0.4219/4)}$

= 0.4219 + 0.9743

= 1.3961

LCL = u' - 3 $\sqrt{(u'/n)}$

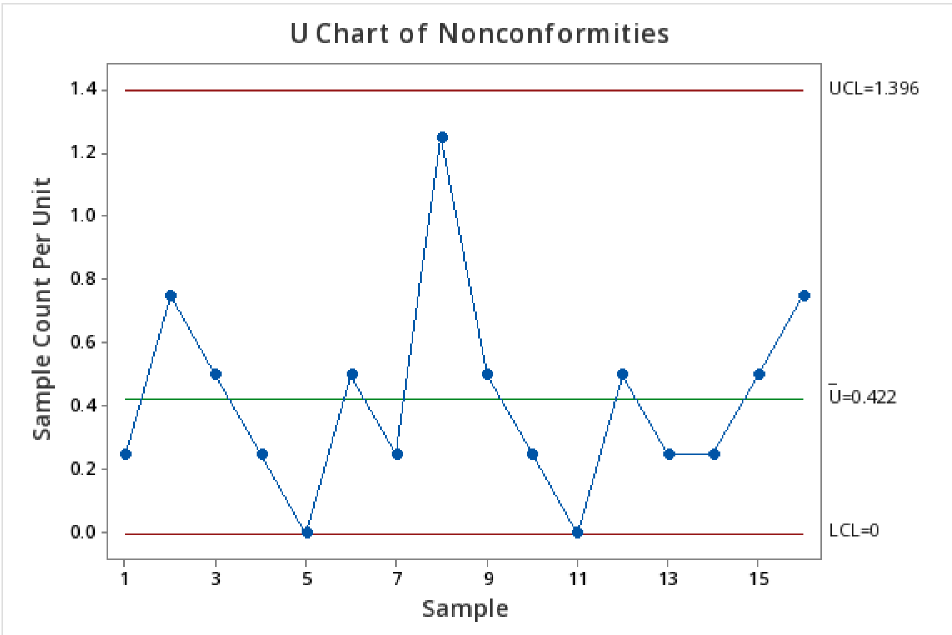
= 0.4219 + 3 $\sqrt{(0.4219/4)}$

= 0.4219 - 0.9743

= -0.5524

Since LCL is less than zero, we assume zero and consider only UCL for the chart.

B. Plot this chart on Minitab or Excel. Is the process in statistical control? Why / why not? (0.25 points)



The process can be said to be **in statistical control** as all points are within control limits and does not fail any significant test methods while checking for not in control points.

Question 4 (modified version of Question 8. 7 in the textbook) – 0.5 points total

A process is in statistical control with mean = 75 and standard deviation = 2. The process specifications are at 80 ± 8. The sample size is n = 5.

A. Estimate the potential capability C_p. (0.17 points).

From L-12, slide 12 w.k.t,

C_p = USL-LSL/6σ

Where, σ^ = s'/control chart constant for n=5

σ = 2/0.94 = 2.13

Subs the above value,

C_p = (80+8)-(80-8) / 6(2.13)

= 88-72/12.87

= 1.2432 or 1.25

B. Estimate the actual capability C_{pk}. (0.17 points)

From L-12, slide 12 w.k.t,

C_{pk} = Min (C_{pl}, C_{pu})

Where,

- $C_{pu} = (USL-\mu) / 3\sigma = (88-75) / 3x2.13 = 2.03$
- $C_{pl} = (\mu-LSL) / 3\sigma = (75-72) / 3x2.13 = 0.47$

Subs the above values,

C_{pk} = Min (0.47, 2.03)

= 0.47

C. How much could process fallout be reduced by shifting the mean to the nominal dimension? Assume that the quality characteristic is normally distributed. In other words, if the process mean is adjusted from 75 to 80, what is the fraction nonconforming? Hint: we solved this type of problems several times before (0.16 points)

$\mu = 80$

$p = P(X < LSL) + P(X > USL)$

$= P(Z < (LSL-\mu)/\sigma) + 1-P(Z < (USL-\mu)/\sigma)$

$= P(Z < (72-80)/2.13) + 1-P(Z < (88-80)/2.13)$

$= P(Z < -3.76) + 1-P(Z < 3.76)$

= 0.0001 + 1-(0.9999) [From table]

= 0.0002

Hence, the value of process fallout by shifting the mean to the nominal dimension in the above scenario is 0.0002.