

Solutions

① $n=5$ $\bar{x}=155$ (normal population)
 $s=4.1$

Upper Control Limit: $\bar{x} + 3\frac{s}{\sqrt{n}} \approx 160.5$

Lower Control Limit: $\bar{x} - 3\frac{s}{\sqrt{n}} \approx 149.5$

② $3\frac{s}{\sqrt{n}}$ would be smaller
So the control limits would be closer to $\bar{x}=155$.

③

Sample	\bar{x}
1	4.94
2	4.94
3	4.95
4	4.7525
5	5.38

 (normal population)

$$\bar{x} = \frac{(4.94 + 4.94 + \dots + 5.38)}{5} = 4.9925$$

$s \approx 0.3285$ ← based on all 20 measurements (Make a Frequency Table)

$n=4$

Lower Control Limit: $\bar{x} - 3\frac{s}{\sqrt{n}} \approx 4.500$

Upper Control Limit: $\bar{x} + 3\frac{s}{\sqrt{n}} \approx 5.485$

④ NONE. All the \bar{x} values lie within the Control Limits.

⑤ (normal population)

Sample	\bar{x}
1	8.4575
2	8.8325
3	8.3975
4	8.405
5	8.45
6	8.3975

$$\bar{\bar{x}} = \frac{(8.4575 + 8.8325 + \dots + 8.3975)}{6}$$
$$= 8.49$$

To get s , make a Frequency Table:

X	Freq
8.39	9
8.42	9
8.57	3
8.92	3

$$s \approx 0.1754$$

$n=4$

$$\text{Upper Control Limit: } \bar{\bar{x}} + 3 \frac{s}{\sqrt{n}} \approx 8.7531$$

$$\text{Lower Control Limit: } \bar{\bar{x}} - 3 \frac{s}{\sqrt{n}} \approx 8.2269$$

Sample #2 generates a warning,

Sample	\hat{p}
1	$8/400 = 0.02$
2	$5/400 = 0.0125$
3	0.0425
4	0.0075
5	0.03

$$\bar{p} = \frac{(0.02 + 0.0125 + \dots + 0.03)}{5} = 0.0225$$

$$\bar{q} = 1 - \bar{p} = 0.9775 \quad (n=400)$$

(Assumptions: $n\bar{p} > 5$ and $n\bar{q} > 5$ ✓)

$$\text{Lower Control Limit: } \bar{p} - 3\sqrt{\frac{\bar{p}\bar{q}}{n}} \approx 0.0003$$

$$\text{Upper Control Limit: } \bar{p} + 3\sqrt{\frac{\bar{p}\bar{q}}{n}} \approx 0.0447$$

⑦ None. All \hat{p} values are within the Control Limits.

⑧

Sample	\hat{p}
1	$1/160 = 0.00625$
2	$4/160 = 0.025$
3	0.03125
4	0.01875
5	0.08125

$$\bar{p} = \frac{(0.00625 + 0.025 + \dots + 0.08125)}{5}$$

$$= 0.0325$$

$$\bar{q} = 1 - \bar{p} = 0.9675 \quad (n=160)$$

(Assumptions: $n\bar{p} > 5$ and $n\bar{q} > 5$ ✓)

$$\text{Upper Control Limit: } \bar{p} + 3\sqrt{\frac{\bar{p}\bar{q}}{n}} \approx 0.0746$$

$$\text{Lower Control Limit: } \bar{p} - 3\sqrt{\frac{\bar{p}\bar{q}}{n}} \approx -0.0096$$

A warning is generated for Sample 5 because $\hat{p} = 0.08125$ is outside the Control Limits.

⑨

Sample	\hat{p}
1	$1/150 \approx 0.0067$
2	$4/160 = 0.025$
3	$5/100 = 0.05$
4	$3/120 = 0.025$
5	$13/100 = 0.13$

$$\bar{p} = \frac{(0.0067 + 0.025 + 0.05 + 0.025 + 0.13)}{5}$$

$$\approx 0.0473$$

$$\bar{n} = \frac{150 + 160 + 100 + 120 + 100}{5} = 126$$

⑩ From #9: $\bar{p} \approx 0.0473$ $\bar{n} = 126$

$$\bar{q} = 1 - \bar{p} \approx 0.9527$$

(Assumptions: $\bar{n}\bar{p} > 5$ and $\bar{n}\bar{q} > 5$ ✓)

Upper Control Limit: $\bar{p} + 3\sqrt{\frac{\bar{p}\bar{q}}{\bar{n}}} \approx 0.1040$

Lower Control Limit: $\bar{p} - 3\sqrt{\frac{\bar{p}\bar{q}}{\bar{n}}} \approx -0.0094$

Sample 5 generates a warning
 \hat{p} is outside the Control Limits