

Lecture Notes on Statistical Quality Control

Ex: To study the aspect of service quality that relates to the amount of time it takes to deliver luggage (as measured from the time the guest completes check-in procedures to the time the luggage arrives in the guest's room), data were recorded over a 4-week period. Sub-groups of five deliveries were selected from the evening shift on each day for analysis. The following table summarizes the results for all 28 days:

Day	Luggage Delivery Times in Minutes					Average	Range
1	6.7	11.7	9.7	7.5	7.8	8.68	5.0
2	7.6	11.4	9.0	8.4	9.2	9.12	3.8
3	9.5	8.9	9.9	8.7	10.7	9.54	2.0
4	9.8	13.2	6.9	9.3	9.4	9.72	6.3
5	11.0	9.9	11.3	11.6	8.5	10.46	3.1
6	8.3	8.4	9.7	9.8	7.1	8.66	2.7
7	9.4	9.3	8.2	7.1	6.1	8.02	3.3
8	11.2	9.8	10.5	9.0	9.7	10.04	2.2
9	10.0	10.7	9.0	8.2	11.0	9.78	2.8
10	8.6	5.8	8.7	9.5	11.4	8.80	5.6
11	10.7	8.6	9.1	10.9	8.6	9.58	2.3
12	10.8	8.3	10.6	10.3	10.0	10.00	2.5
13	9.5	10.5	7.0	8.6	10.1	9.14	3.5
14	12.9	8.9	8.1	9.0	7.6	9.30	5.3
15	7.8	9.0	12.2	9.1	11.7	9.96	4.4
16	11.1	9.9	8.8	5.5	9.5	8.96	5.6
17	9.2	9.7	12.3	8.1	8.5	9.56	4.2
18	9.0	8.1	10.2	9.7	8.4	9.08	2.1
19	9.9	10.1	8.9	9.6	7.1	9.12	3.0
20	10.7	9.8	10.2	8.0	10.2	9.78	2.7
21	9.0	10.0	9.6	10.6	9.0	9.64	1.6
22	10.7	9.8	9.4	7.0	8.9	9.16	3.7
23	10.2	10.5	9.5	12.2	9.1	10.30	3.1
24	10.0	11.1	9.5	8.8	9.9	9.86	2.3
25	9.6	8.8	11.4	12.2	9.3	10.26	3.4
26	8.2	7.9	8.4	9.5	9.2	8.64	1.6
27	7.1	11.1	10.8	11.0	10.2	10.04	4.0
28	11.1	6.6	12.0	11.5	9.7	10.18	5.4

Draw the \bar{X} and R-Charts and comment on the results.

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Sol:

Luggage Delivery Times

Data	
Sample/Subgroup Size	5

R Chart Intermediate Calculations	
RBar	3.482142857
D3 Factor	0
D4 Factor	2.114

R Chart Control Limits	
Lower Control Limit	0
Center	3.482142857
Upper Control Limit	7.36125

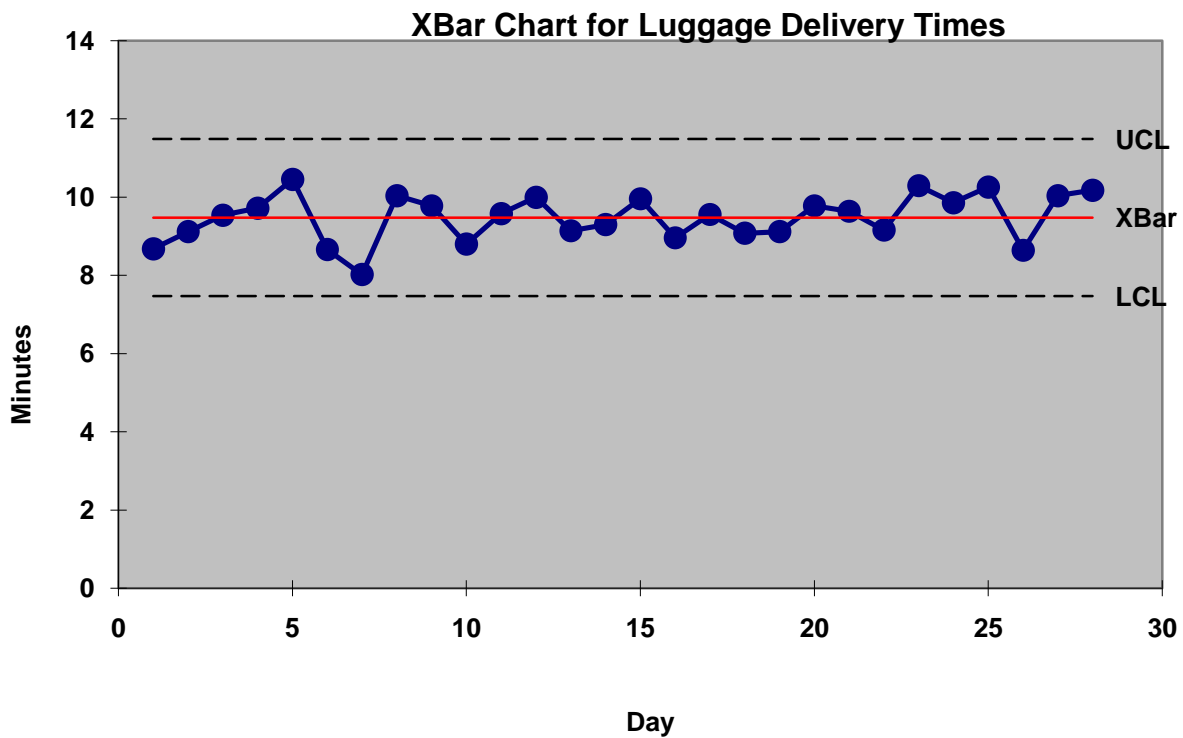
XBar Chart Intermediate Calculations	
Average of Subgroup Averages	9.477857143
A2 Factor	0.577
A2 Factor * RBar	2.009196429

XBar Chart Control Limits	
Lower Control Limit	7.468660714
Center	9.477857143
Upper Control Limit	11.48705357

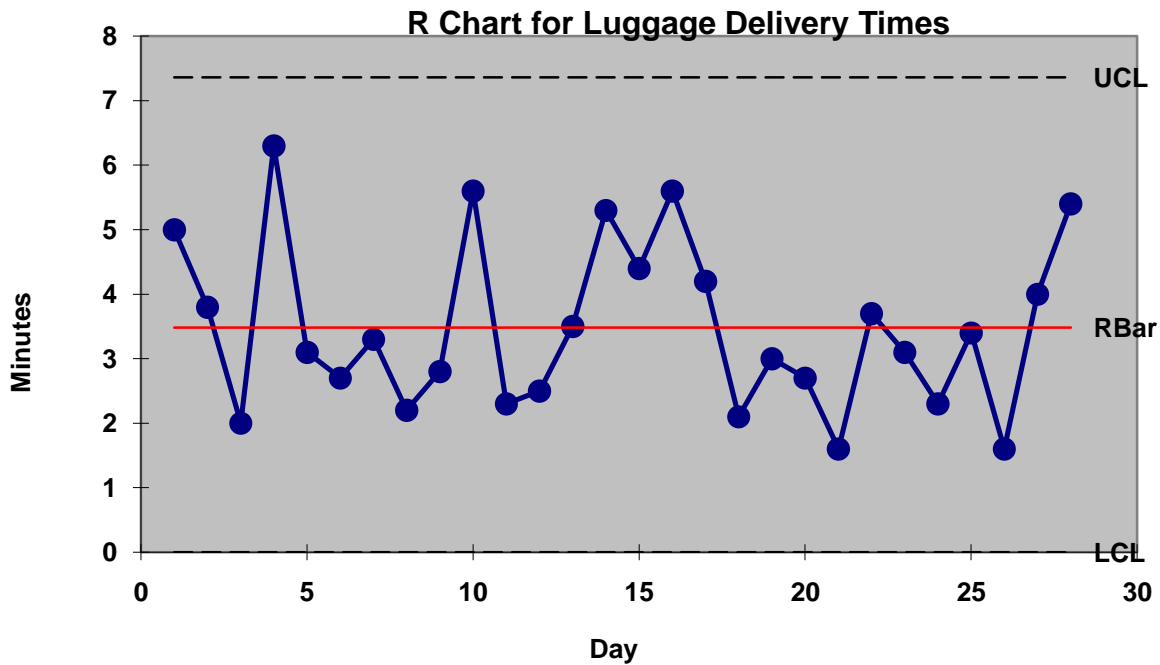
Number	XBar	Range	LCL-R	Center-R	UCL-R	LCL-X	Center-X	UCL-X
1	8.68	5	0	3.482143	7.36125	7.468661	9.477857	11.48705
2	9.12	3.8	0	3.482143	7.36125	7.468661	9.477857	11.48705
3	9.54	2	0	3.482143	7.36125	7.468661	9.477857	11.48705
4	9.72	6.3	0	3.482143	7.36125	7.468661	9.477857	11.48705
5	10.46	3.1	0	3.482143	7.36125	7.468661	9.477857	11.48705
6	8.66	2.7	0	3.482143	7.36125	7.468661	9.477857	11.48705
7	8.02	3.3	0	3.482143	7.36125	7.468661	9.477857	11.48705
8	10.04	2.2	0	3.482143	7.36125	7.468661	9.477857	11.48705
9	9.78	2.8	0	3.482143	7.36125	7.468661	9.477857	11.48705
10	8.8	5.6	0	3.482143	7.36125	7.468661	9.477857	11.48705
11	9.58	2.3	0	3.482143	7.36125	7.468661	9.477857	11.48705
12	10	2.5	0	3.482143	7.36125	7.468661	9.477857	11.48705
13	9.14	3.5	0	3.482143	7.36125	7.468661	9.477857	11.48705
14	9.3	5.3	0	3.482143	7.36125	7.468661	9.477857	11.48705
15	9.96	4.4	0	3.482143	7.36125	7.468661	9.477857	11.48705
16	8.96	5.6	0	3.482143	7.36125	7.468661	9.477857	11.48705
17	9.56	4.2	0	3.482143	7.36125	7.468661	9.477857	11.48705

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18	9.08	2.1	0	3.482143	7.36125	7.468661	9.477857	11.48705
19	9.12	3	0	3.482143	7.36125	7.468661	9.477857	11.48705
20	9.78	2.7	0	3.482143	7.36125	7.468661	9.477857	11.48705
21	9.64	1.6	0	3.482143	7.36125	7.468661	9.477857	11.48705
22	9.16	3.7	0	3.482143	7.36125	7.468661	9.477857	11.48705
23	10.3	3.1	0	3.482143	7.36125	7.468661	9.477857	11.48705
24	9.86	2.3	0	3.482143	7.36125	7.468661	9.477857	11.48705
25	10.26	3.4	0	3.482143	7.36125	7.468661	9.477857	11.48705
26	8.64	1.6	0	3.482143	7.36125	7.468661	9.477857	11.48705
27	10.04	4	0	3.482143	7.36125	7.468661	9.477857	11.48705
28	10.18	5.4	0	3.482143	7.36125	7.468661	9.477857	11.48705



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Since all the sample points fall within the control limits in both the charts and therefore, we can conclude that the luggage arrives in the guest's time before the time he/she completes check-in procedure.

Note: The above calculations have been made with the help of computer programme. However, students can do the calculations manually with the help of formulae mentioned above and accordingly charts can be drawn manually on the two dimensional graph.

Try: The following data gives readings of 10 samples of size 6 each in the production of a certain component:

Sample:	1	2	3	4	5	6	7	8	9	10
Mean(\bar{X}):	383	508	505	582	557	337	514	614	707	753
Range(R):	95	128	100	91	68	65	148	28	37	80

Draw the \bar{X} – chart.

Ex: The following data gives reading of 10 samples of size 6 in the production of certain components:

Sample No.:	1	2	3	4	5	6	7	8	9	10
S.D(s):	30.5	41.6	39.5	32.2	27.4	24.2	48.7	89	50.7	33.9

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Calculate control limits for S-chart.

Sol: $\bar{s} = 41.77$, B_4 for $n=6$ is 1.97, B_3 for $n=6$ is 0.03

$UCL = B_4 \bar{s} = 82.28$, $CL = 41.77$ and $LCL = B_3 \bar{s} = 1.25$