

USING STATISTICS FOR QUALITY CONTROL

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QUESTION 1.

In the box below explain what 'statistical process control' is and what 'acceptance sampling' is.

Statistical process control is a method which uses statistical methods in order to monitor a control variable and attribute data.

Acceptance sampling is a method used to make a decision as to whether to accept or reject lots based on the inspection of samples.

QUESTION 2.

Write down two possible causes of quality variation in a manufacturing process and give an example of each:

1. Quality of raw materials. Plastic used in injection moulding is one example.
2. Machines out of calibration. Variations in diameters of bolts is one example.

Complete the following table:

Decision	Process in control	Process out of control
Accept	$H_0 = \text{true}$	Type II error
Change process	Type I error	$H_0 = \text{false}$

Complete the following:

A Type I error occurs when H_0 is rejected when it is true.

A Type II error occurs when H_0 is not rejected when it should be.

QUESTION 3.

Complete the following: The UCL (upper control limit) is given by $\mu + 3\sigma$ and the LCL (lower control limit) is given by $\mu - 3\sigma$. If the mean of the sample falls between these limits there is a 99.7 % probability the mean is within acceptable limits and therefore we consider the process to be in control.

QUESTION 4.

You have been asked to advise the Production Manager of a manufacturing company whether a particular process is operating in statistical control. The company manufactures drive shafts. The Quality Control department have taken 10 samples comprising of 100 drive shafts each. Each sample is independent from the other and the drive shafts are selected at random. The table below shows the results of the sampling.

Sample ID	1	2	3	4	5	6	7	8	9	10
Sample range	0.5	0.2	0.3	0.8	0.4	0.1	0.2	0.6	0.3	0.4

The CL (Control Limit) $\bar{\bar{x}} = 0.38$

The value of the mean range across the samples, $\bar{R} = 0.38$

The value of A_2 in the formula $UCL = \bar{\bar{x}} + A_2\bar{R}$ is 0.308

The UCL = 0.497

The LCL = 0.263

Complete the following sentence:

Providing the individual sample means are within the LCL and the UCL, the process is said to be in statistical control. If a particular sample mean was outside of this range it would be out of control and further investigation would be necessary.

QUESTION 5.

You have been commissioned to investigate the number of readmissions to a local hospital. The management team are concerned that patients may be being discharged too early so that the clinical teams meet their targets for discharges.

The table below shows the data collected over the past 12 months.

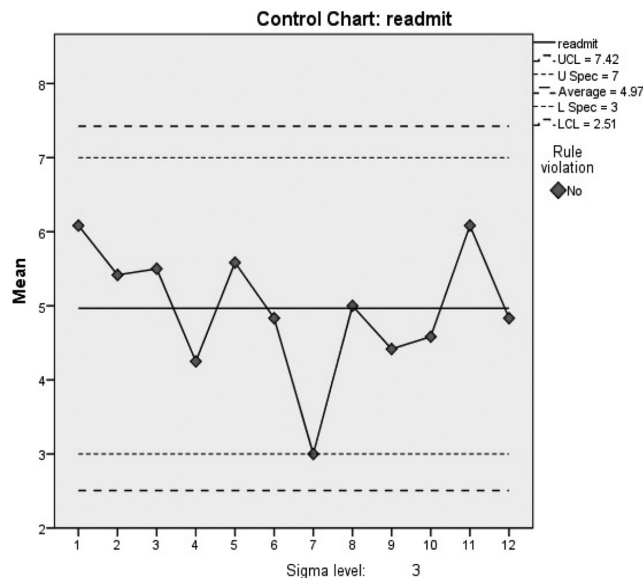
Month no.	1	2	3	4	5	6	7	8	9	10	11	12
Mean readmissions	6.08	5.42	5.5	4.25	5.58	4.83	3.00	5.00	4.42	4.58	6.08	4.83

In order to do the analysis you need to select an appropriate control chart.

In the box below state the type of chart you would use to monitor the readmissions and explain why you made this choice.

Variable chart since the readmissions are being measured.

The figure below shows a control chart from the readmissions data.



Complete the following statements:

The calculated UCL = 7.42

The specified UCL = 7

The calculated LCL = 2.51

The specified LCL = 3

In the box below interpret the chart in terms of the monthly variations. For example, could there be a reason why the readmissions for July were less than for any other month, etc.?

The control chart indicates the process is in control. July's result could be due to staff unavailability, good weather impact on health.

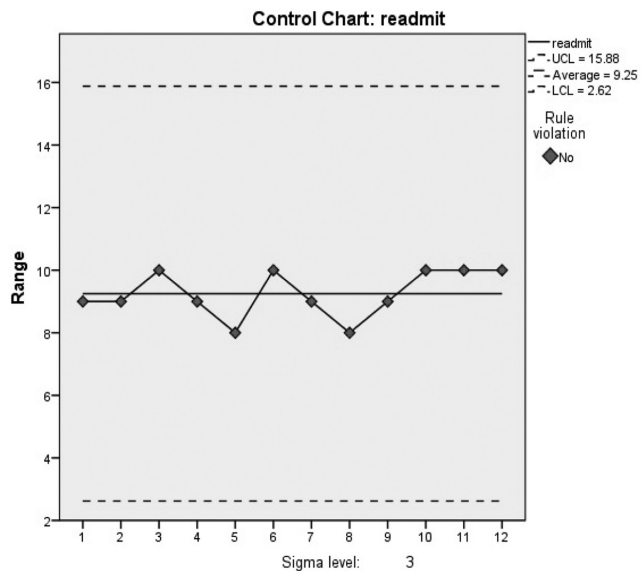
The control chart below shows the range of the data about the mean.

Complete the following:

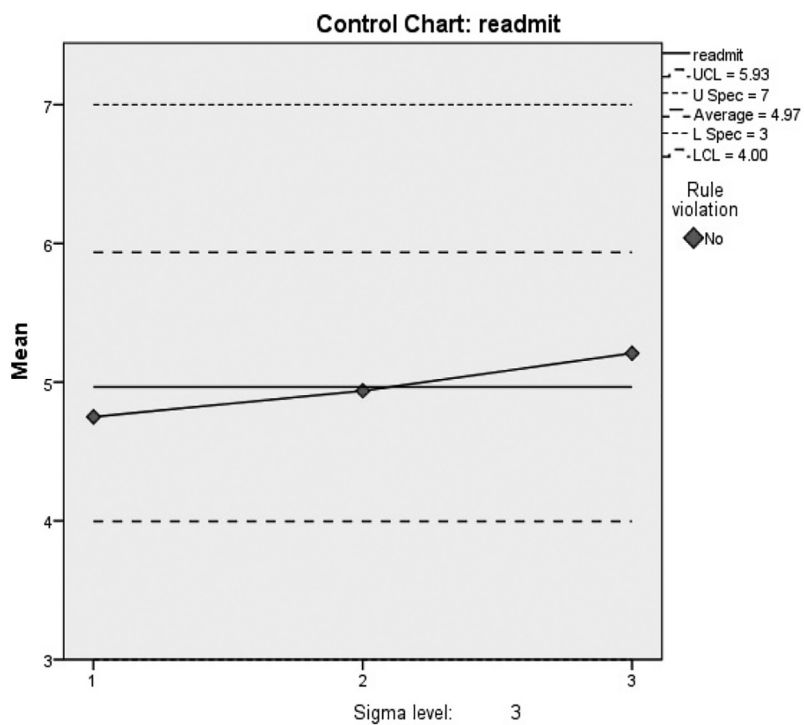
The solid centre line represents the mean of the sample range.

The control limits reflect the expected amount of variation in the sample ranges when only expected causes of variation are present.

The chart indicates for October, November and December there is no variation in the range. This could indicate the start of a problem, therefore further investigations are necessary to make a judgement. In order to make a judgement a p chart could be used.



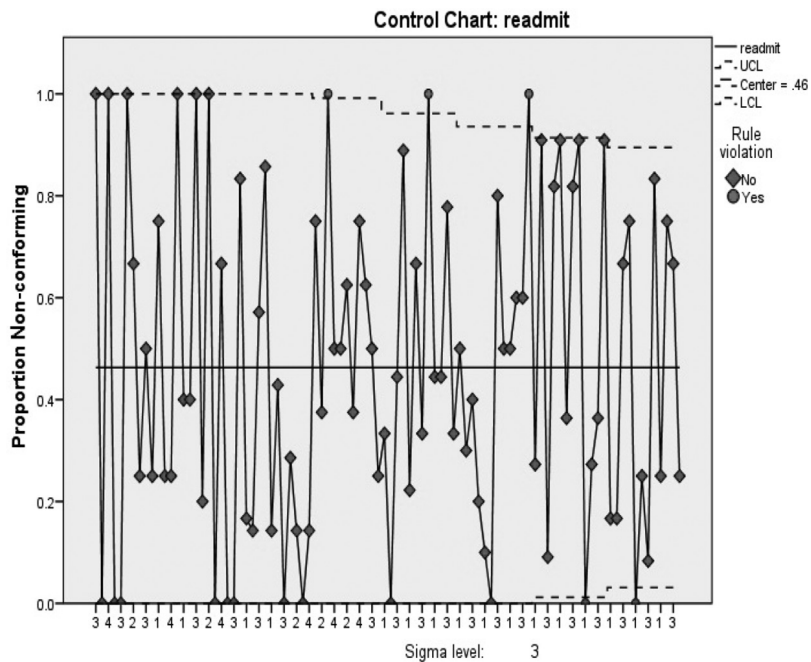
You decide also to look at the readmissions by ward. The figure below shows the control chart for this activity.



In the box below interpret what the chart is telling you.

Ward 1 readmissions are below average and ward 3 above. It could be staff in ward 1 are more competent and would therefore share best practice. Further investigation would be required before any judgements were made.

For the final part of your analysis you decide to look at the proportion of non-conforming wards. The figure below shows the p control chart for this activity.



The chart indicates that on 5 occasions there were non-conformities which are tabulated below

Ward	Violations for points
4	Greater than $+3\sigma$
3	Greater than $+3\sigma$
3	Greater than $+3\sigma$
1	Less than -3σ
1	Less than -3σ

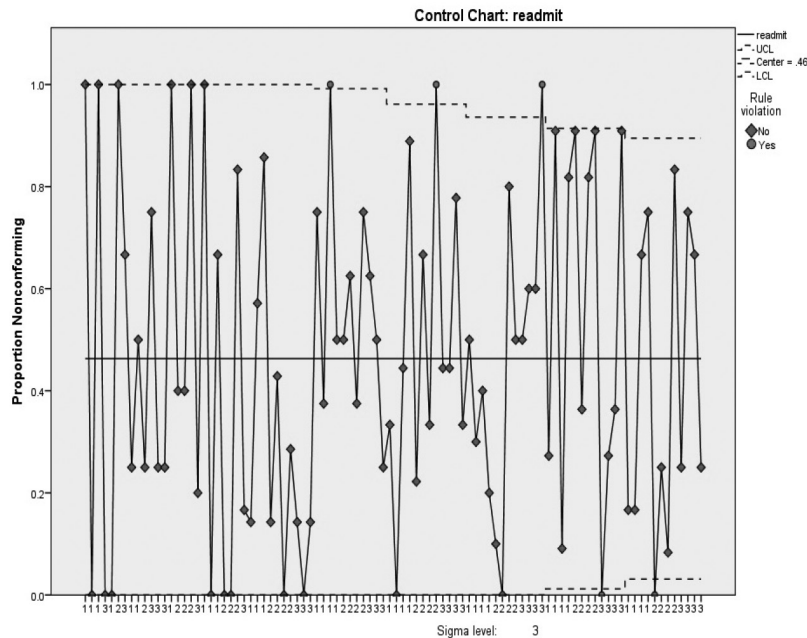
Complete the following:

The readmissions for ward 3 on 1 occasion were greater than 3σ which means readmissions were above the UCL.

Ward 4 had 2 violations.

Ward 1 had 2 violations below the -3σ limit which means on these occasions the number of readmissions was acceptable.

Finally, you decide to look at the shift non-conformities. The figure below shows the results of your analysis.



Shift	Violations for points
1	Greater than $+3\sigma$
2	Greater than $+3\sigma$
3	Greater than $+3\sigma$
3	Less than -3σ
2	Less than -3σ

In the box below, comment on the control chart and the associated rule violations table. In particular discuss any areas that could potentially be a cause for concern.

All 3 shifts had 1 non-conformity above 3σ . This needs further investigation and monitoring.

MINI PROJECT

In question 5 you carried out an investigation into the readmissions data for a local hospital. Your final task is to write a report about the investigation in which you should outline the investigation and the methods you used and the reasons for choosing particular charts. As usual, your target audience are not statistically savvy, so you have to use plain English to inform them of what the data is saying. The final section of your report should contain conclusions and any recommendations you think the management should consider.

And finally...

You have completed the final chapter; well done. Hopefully you feel your knowledge and skills with statistics falls within the range of $+2\sigma$ to $+3\sigma$.