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Improvement Cymru Academy Toolkit Guide

Statistical Process Control

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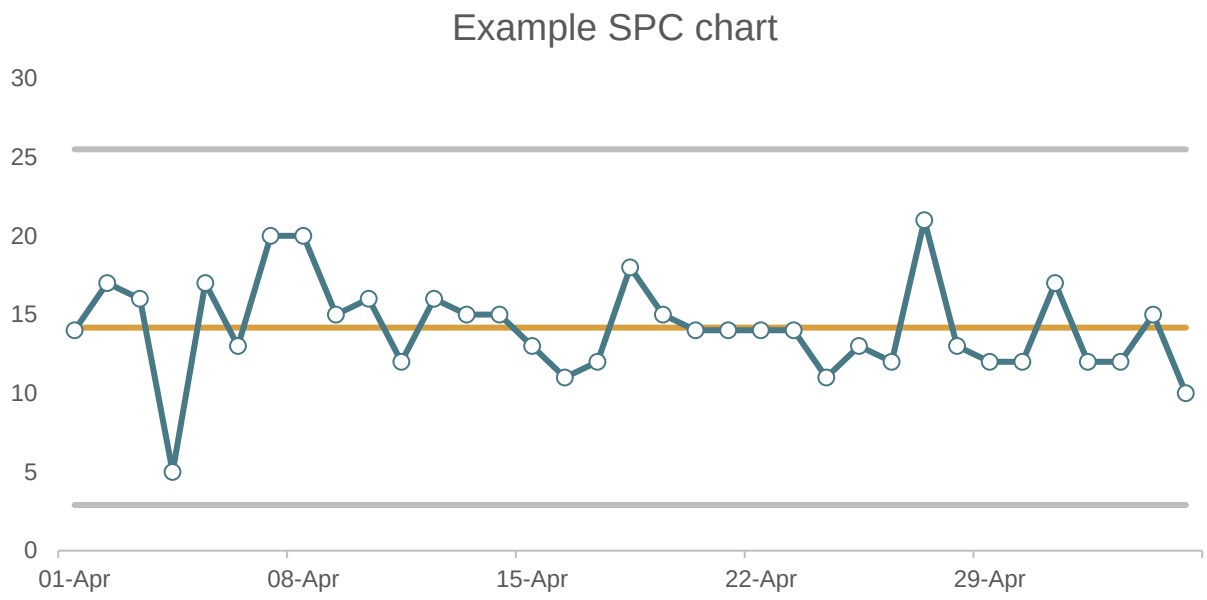
Introduction

What is a Statistical Process Control chart?

A Statistical Process Control (SPC) chart, also known as a “Shewhart chart” or “control chart”, is one of two types of charts (run charts being the other type of chart) used in improvement to support the interpretation of measures presented over time. This chart helps you to understand if your process has random and/or non-random variation (also known as common cause and/or special cause variation). The centre line is the calculated mean and upper and lower control limits are added to the chart. A control chart allows you to distinguish between the two types of variation to determine process stability, process capability and to select the appropriate improvement strategy.

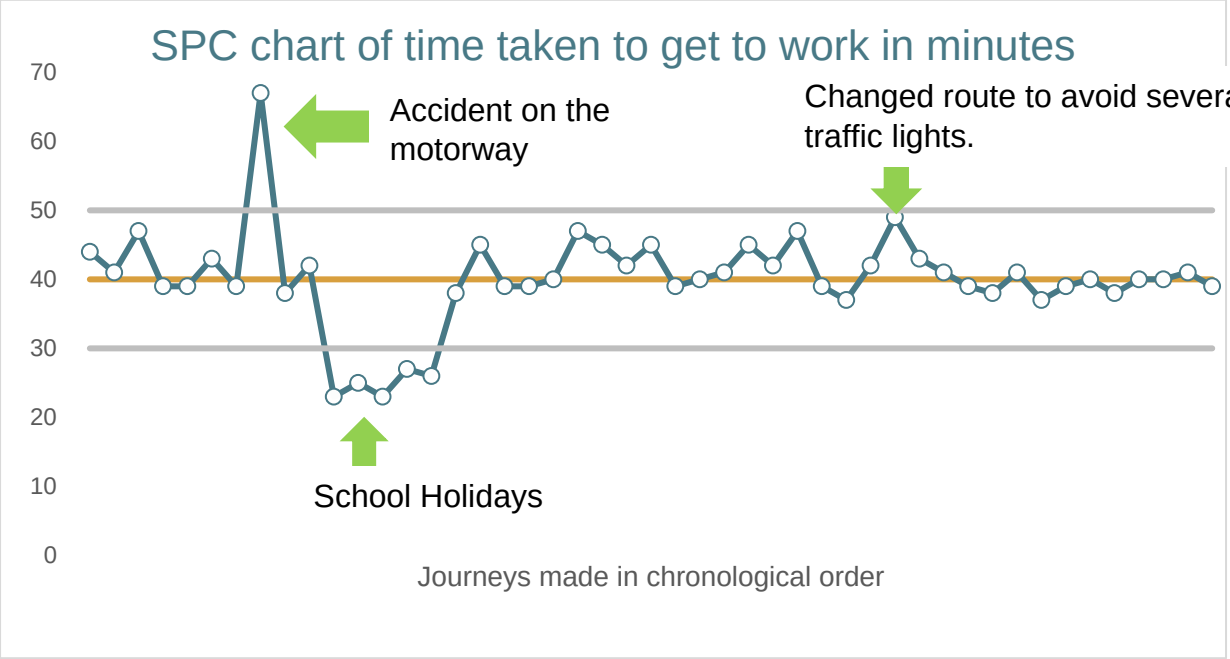


Background

SPC charts were developed at Bell Laboratories in 1920 by Walter A. Shewhart, the father of SPC. Well versed in the statistical theories of his day, Shewhart was able to detect differences in the sources of variation of a process. Walter Shewhart enabled Western Electric Company to assist their engineers in improving the quality of telephone hardware at this time.

An example:

Here is an example of a SPC chart showing the time it takes to drive to work each day over 6 weeks, indicating variation over time with events.



An event above the control limits is known as an astronomical data point which is seen where there was an accident on the motorway, with roads being quieter during school holidays and the process returning to within control limits on day 18 when school re-opened. The rest of the variation seems to be due to natural differences in how busy the road was each day.

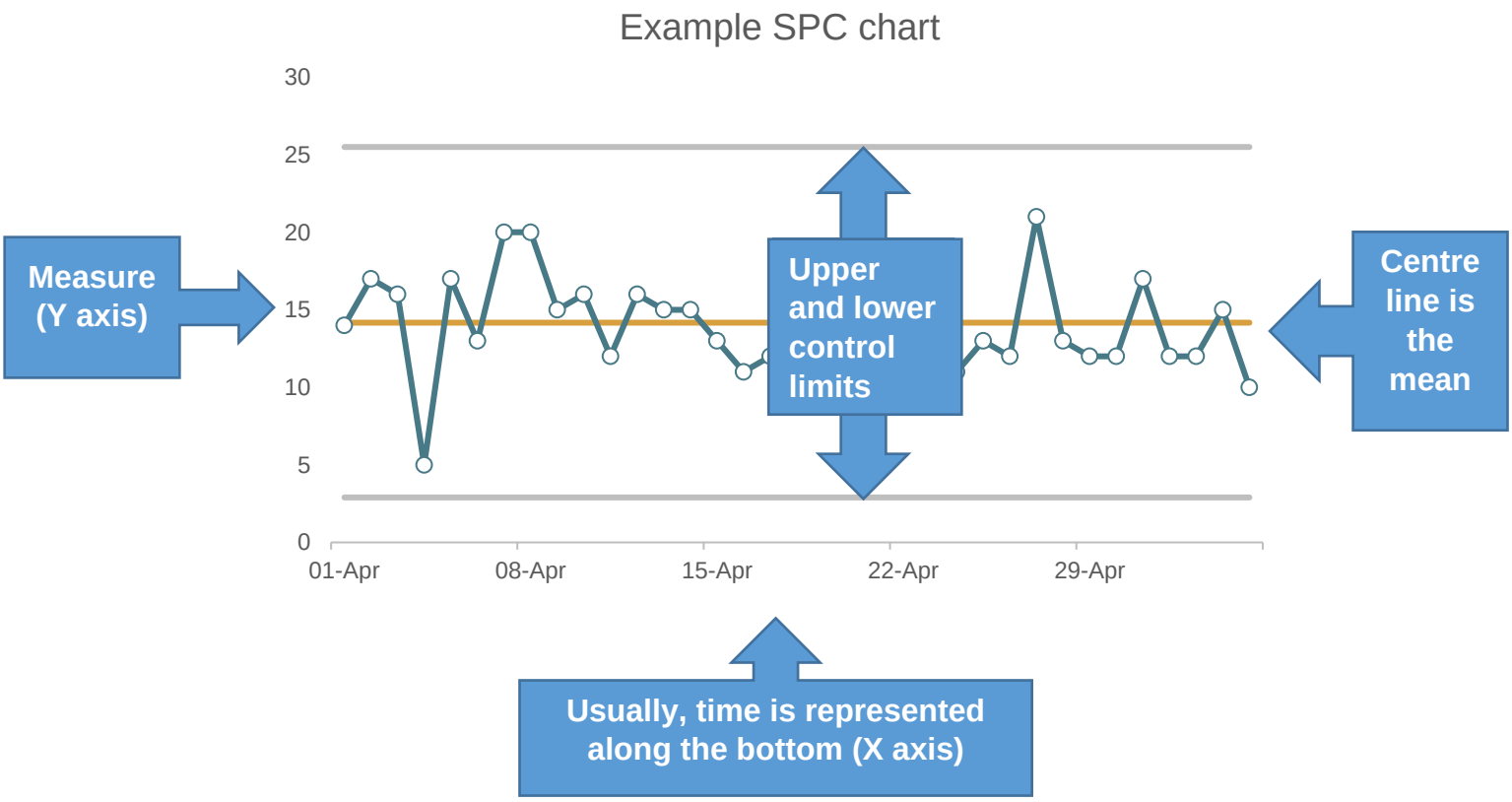
How to use an SPC Chart

The key concepts of a SPC chart:

- SPC charts use control limits to distinguish between random variation and non-random variation. Upper control limits (UCL) and lower control limits (LCL) help identify when a process is out of control.
- Variation refers to the spread of data overtime. SPC focuses on understanding and reducing process variation. SPC Charts help differentiate between random

variation, which is expected in the process, and non-random variation, which indicates a specific problem affecting the process.

- The process mean represents the average value of a process, calculated from some or all of the process measurements.



Variation in SPC charts

There are two types of variation found within SPC charts:

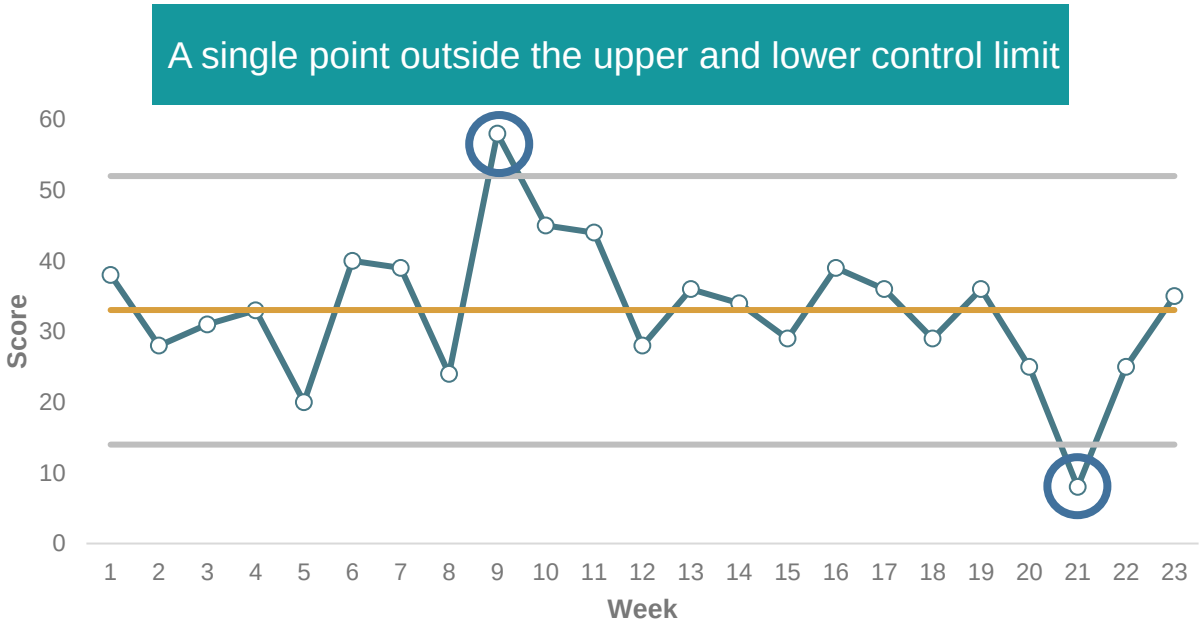
- Random variation
  - Is inherent in the design of the process.
  - Results in a stable – **in control** – process because the variation is predictable.
  - Is due to random or change causes of variation.
- *Non-random variation*
  - Is due to irregular or unnatural causes that are not inherent in a process - extrinsic.
  - Results in an unstable –**out of control**– process because variation is not predictable.

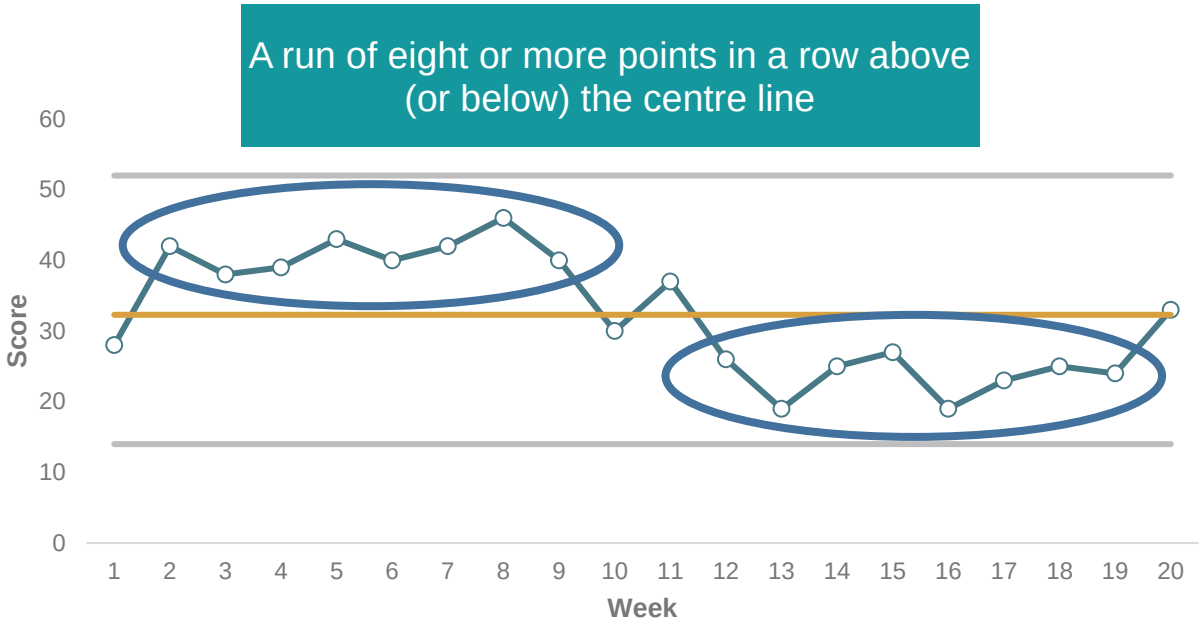
- Is due to non-random or assignable causes of variation (i.e. a signal that the process has ‘changed’)

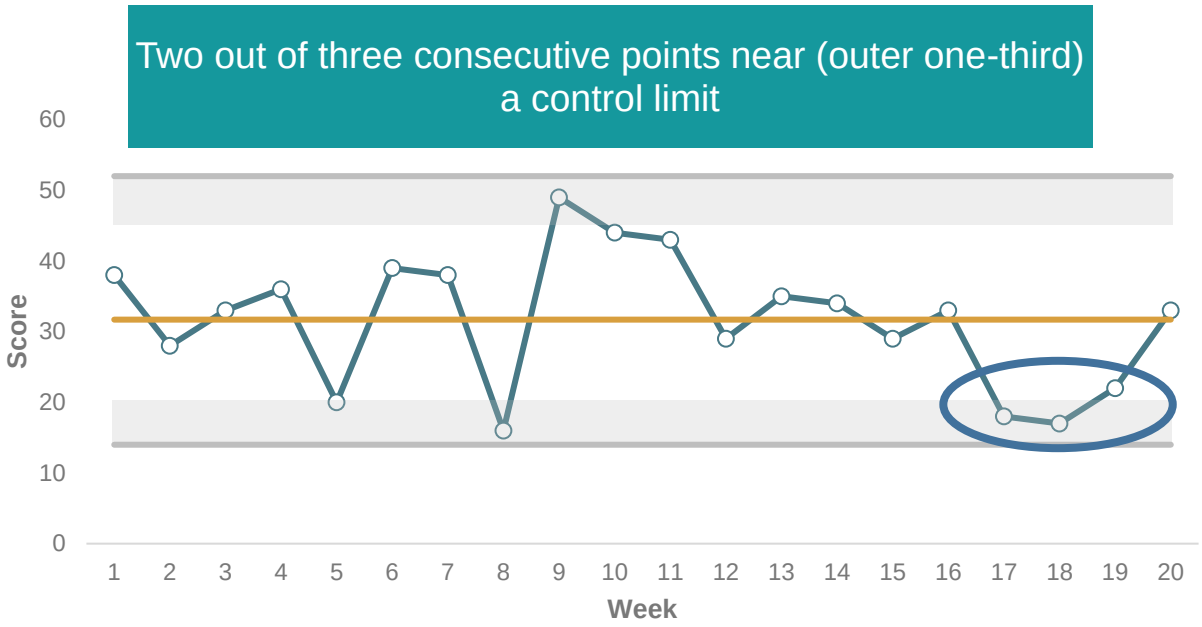
In general, random variation occurs between the upper and lower limit and non-random variation occurs outside of these limits.

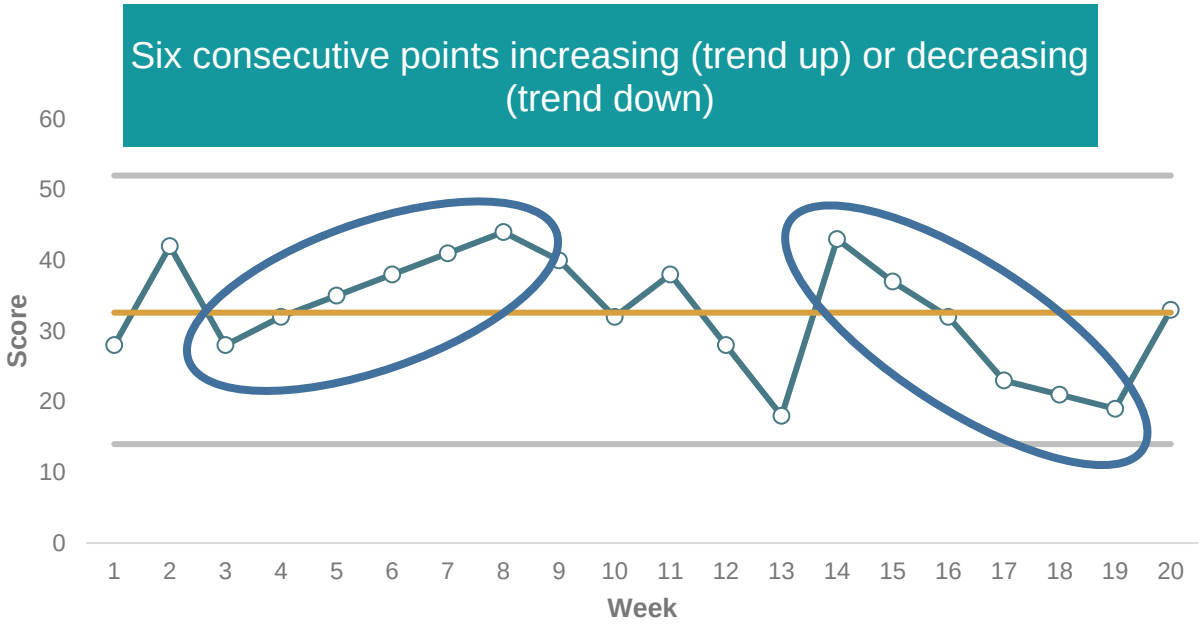
Identifying signals

There are rules that outline non-random variation that may be occurring in a process that use the control limits. These rules can be used to outline issues as well highlight improvements.




A run of eight or more points in a row above (or below) the centre line
60
50
40
30
20
10
0
Score
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Week


Two out of three consecutive points near (outer one-third) a control limit
60
50
40
30
20
10
0
Score
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Week



When to use SPC charts

SPC is a good technique to use when implementing change as it enables you to understand whether changes you are making are resulting in improvement — a key component of the Model for Improvement widely used within the NHS (See Model for Improvement toolkit guide here for more information).

The use of a SPC chart will enable you to:

- record your data on a daily, weekly, or monthly basis.
- indicate when a process may have changed by applying SPC rules to the data.
- annotate your chart and appropriately apply step changes to your mean and process limits.

A SPC charts enables us to determine if an improvement is improving a process and to ‘predict’ statistically whether a process is ‘capable’ of meeting a goal.

Benefits of using SPC Charts

SPC charts:

- Provide visual signals when a process is moving out of control or exhibiting special cause variation**.**
- Enables ongoing process improvement and the ability to increase the levels of quality and efficiency.
- Facilitates the use of plan, do, study, act (PDSA) cycles to test a change theory for improvement and implement successful changes.
- Can track implementation efforts to assure sustainability of your improvements.

Summary

SPC charts improve quality by allowing early detection and prevention of defects, ensuring process stability, reducing variation, optimising processes, allowing continuous improvement.

SPC charts can be used to:

- Identify if a process is sustainable.
- Identify signals of improvement
- Identify when an implemented improvement has changed a process.
- Understand that variation is normal and to help reduce it
- Generally, understand processes - helping make better predictions and thus improve decision making.
- Recognise abnormalities within processes.
- Prove or disprove assumptions and (mis) conceptions about services.
- Drive improvement – used to test the stability of a process prior to redesign work.
- Improve quality of a process

Additional Resources

If you would like more information on how the improvement model can support you or your organisation, we welcome you to visit our website. https://phw.nhs.wales/services-and-teams/improvement-cymru/improvement-cymru-academy/

Or email us improvementcymruacademy@wales.nhs.uk to find about the improvement courses we offer.

Further Reading

Lean Six Sigma (2021). Introduction to Statistical Process Control Charts. Available at: https://www.youtube.com/watch?v=Kw_ZMiMNi04 (Accessed 21 Jul 2023)

NHS England (No Date). Statistical Process Control. Available at: https://www.england.nhs.uk/wp-content/uploads/2022/02/qsir-statistical-process-control.pdf (Accessed 21 Jul 2023)

NHS England (No date). Statistical Process Control Tool. Available at: https://www.england.nhs.uk/statistical-process-control-tool/ (Accessed 21 Jul 2023)

Six Sigma Money Belt (2011). What is SPC (Statistical Process Control). Available at: https://www.youtube.com/watch?v=0GfBSuwhUwI (Accessed 21 Jul 2023)