

Shewhart Control Charts

T Chart: Formula



T Chart Formula

Data

Date of Fall	Days Between Falls (t)	Transformed Days Between Falls (y)	Moving Range of y (MR = y _t - y _(t+1))
02/03/2014			
06/03/2014	4	1.5	
07/03/2014	1	1.0	0.5
15/03/2014	8	1.8	0.8
22/03/2014	7	1.7	0.1
01/04/2014	10	1.9	0.2
11/04/2014	10	1.9	0.0
14/04/2014	3	1.4	0.5
26/04/2014	12	2.0	0.6
03/05/2014	7	1.7	0.3
04/05/2014	1	1.0	0.7
13/05/2014	9	1.8	0.8
28/05/2014	15	2.1	0.3
04/06/2014	7	1.7	0.4
10/06/2014	6	1.6	0.1
14/06/2014	4	1.5	0.2
21/06/2014	7	1.7	0.2
30/06/2014	9	1.8	0.1

$\sum y$	28.2	$\sum MR$	5.8
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n = total number of falls
 t = time between falls
 ($t \neq 0$, more specific measurement required e.g. hours, minutes.)
 $y = t^{0.2777}$
 $\bar{y}$ = average of y's
 MR = moving range of y's
 $\overline{MR}$ = average moving range of y's

Calculation

$n = 18$

Calculate $\bar{y}$. This will be used to calculate the CL, UCL and LCL

$$\bar{y} = \frac{\sum y}{n-1} = \frac{28.2}{17} = 1.7 \text{ (1.d.p.)}$$

Calculate $\overline{MR}$ and $3.27\overline{MR}$. Remove any y values where $y > 3.27\overline{MR}$. This is necessary to ensure the limits aren't affected by special cause variation.

$$\overline{MR} = \frac{\sum MR}{n-2} = \frac{\sum (y_i - y_{(i+1)})}{n-2} = \frac{5.8}{16} = 0.4 \text{ (1.d.p.)}$$

$$3.27 \overline{MR} = 3.27 \times 0.4 = 1.2 \text{ (1.d.p.)}$$

Use the remaining MR values to calculate $\overline{MR}'$. In this instance, none of the MR values are greater than 1.2 therefore $\overline{MR}' = \overline{MR} = 0.4$

Calculate the UL and LL . These will be used to calculate the UCL and LCL

$$\begin{aligned}
 UL &= \bar{y} + 2.66 \times \overline{MR}' & LL &= \bar{y} - 2.66 \times \overline{MR}' \\
 &= 1.7 + 2.66 \times 0.4 & &= 1.7 - 2.66 \times 0.4 \\
 &= 2.6 \text{ (1.d.p.)} & &= 0.7 \text{ (1.d.p.)}
 \end{aligned}$$

Perform the following transformations to calculate the CL, UCL and LCL. When $LL < 0$, then there is no LCL (as per this example).

$$\begin{aligned}
 UCL &= UL^{3.6} & LCL &= LL^{3.6} & CL &= \bar{y}^{3.6} \\
 &= 2.6^{3.6} & &= 0.7^{3.6} & &= 1.7^{3.6} \\
 &= 32.2 & &= 0.3 & &= 6.2
 \end{aligned}$$

Legend + Chart

n = total number of events

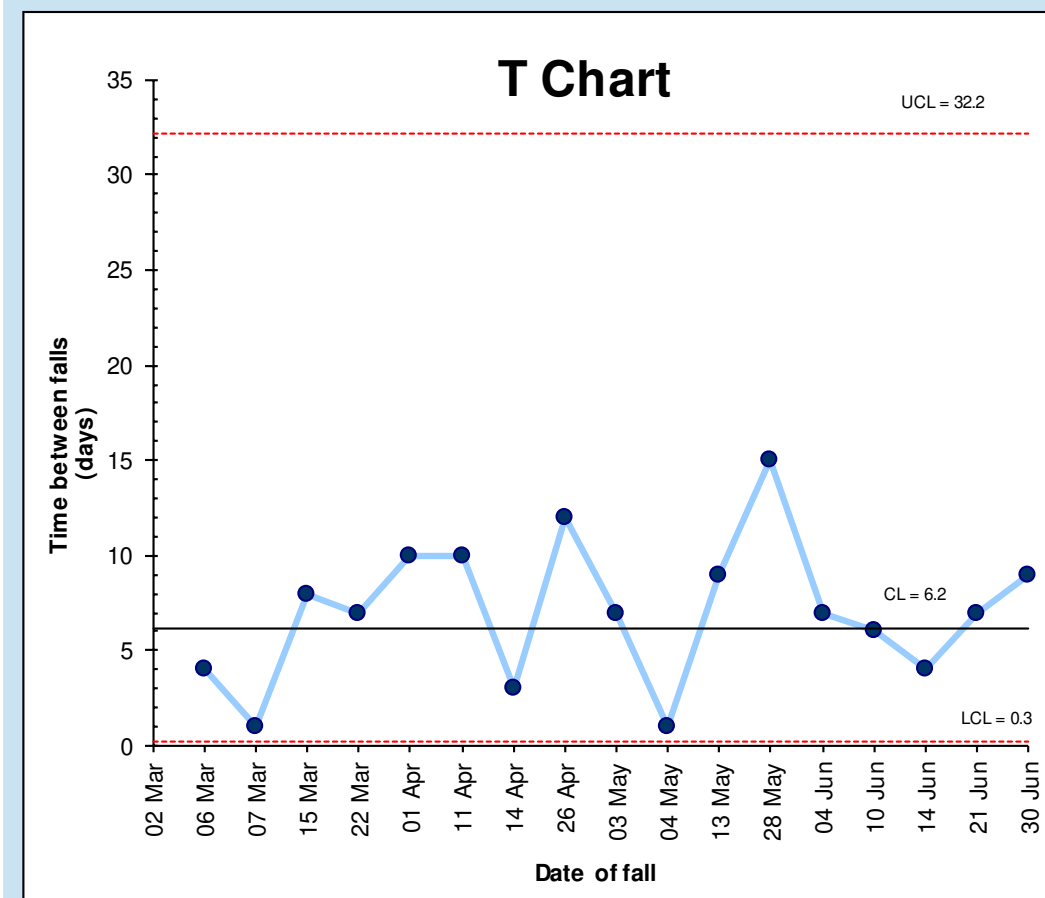
t = time between events

y = transformed time between events ($y = t^{0.2777}$)

UCL = upper control limit

LCL = lower control limit

CL = centre line



The T Chart is sometimes also displayed on a **logarithmic (log₁₀) scale** axis to make the limits appear more symmetrical and creating more visual sensitivity around the LCL