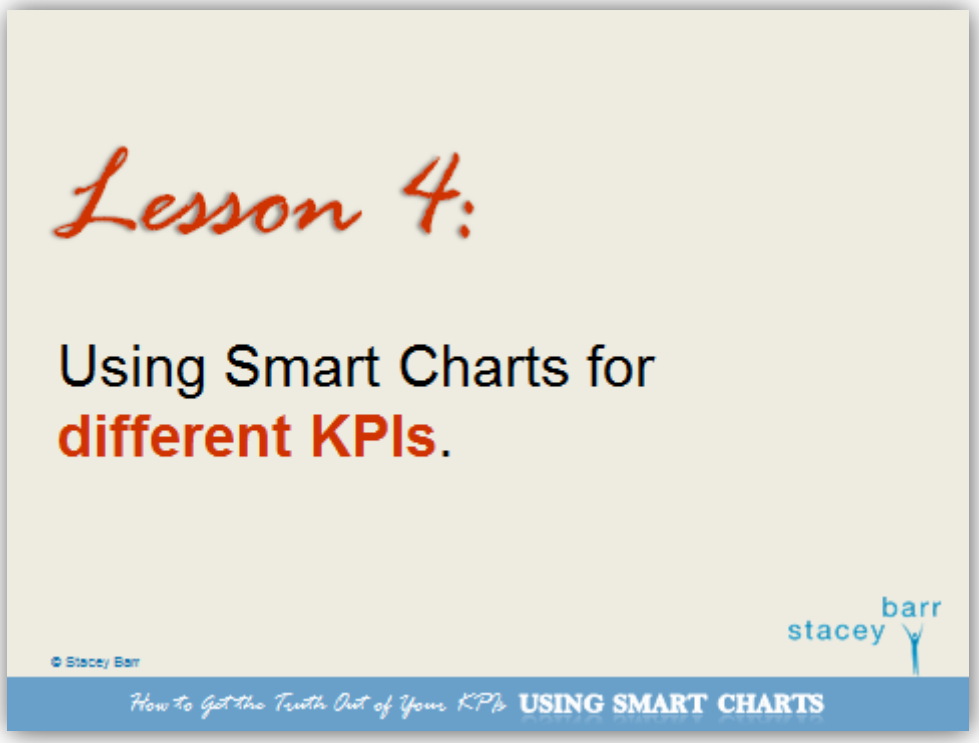
Stacey Barr Pty Ltd
the Performance Measure Specialist
ABN 57 129 953 635
PO Box 422 Samford
Queensland 4520 Australia
Phone: 1800 883 458
info@staceybarr.com
www.staceybarr.com



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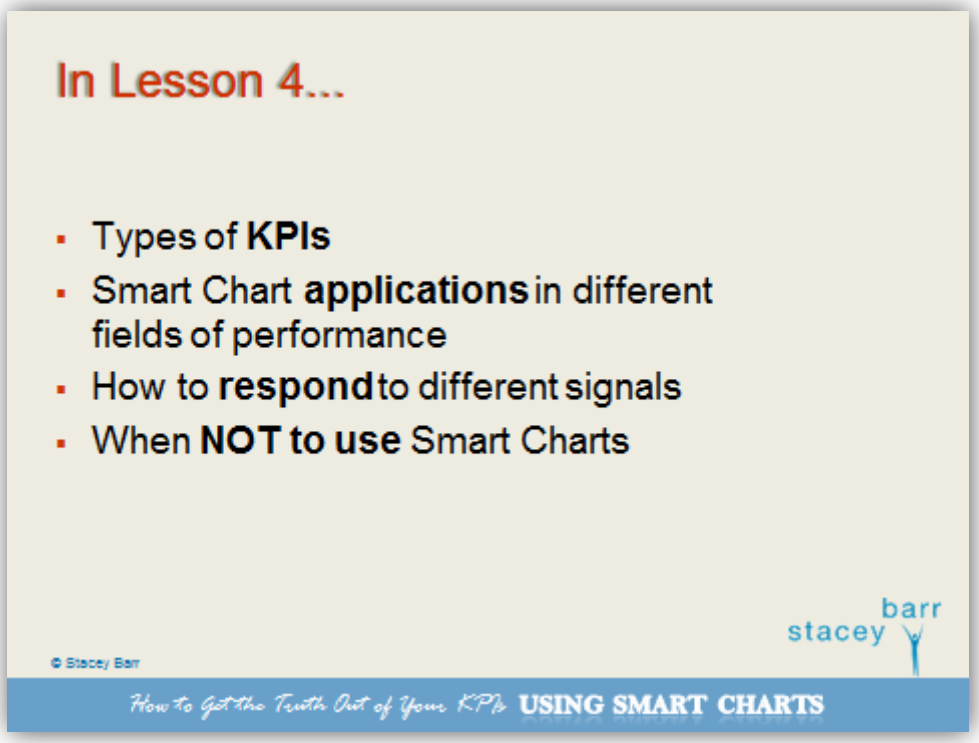

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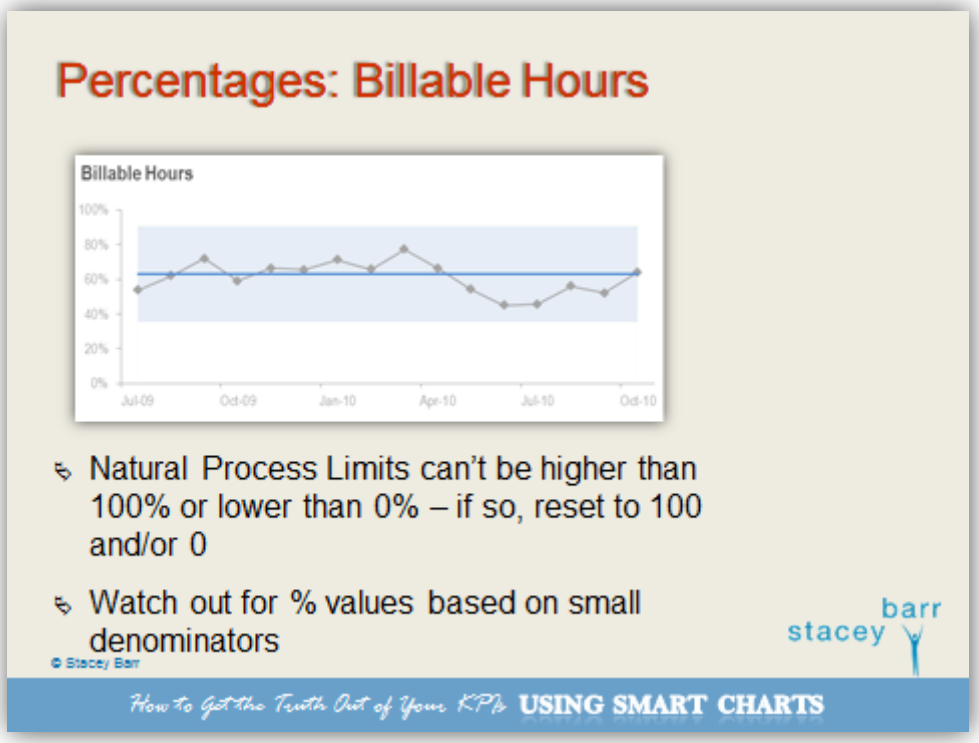

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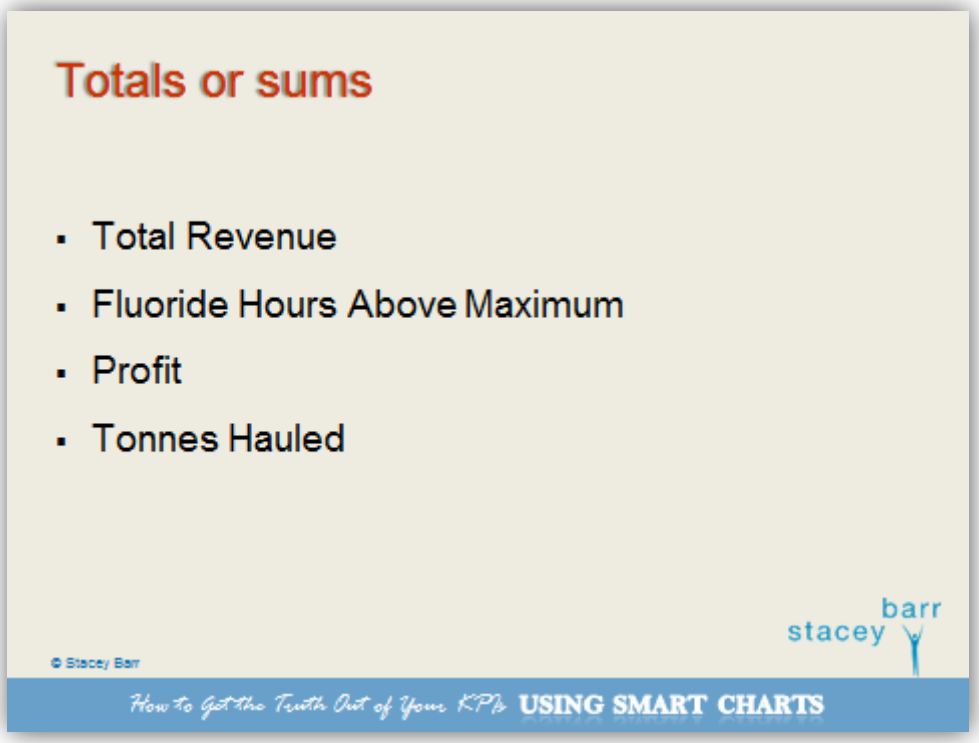

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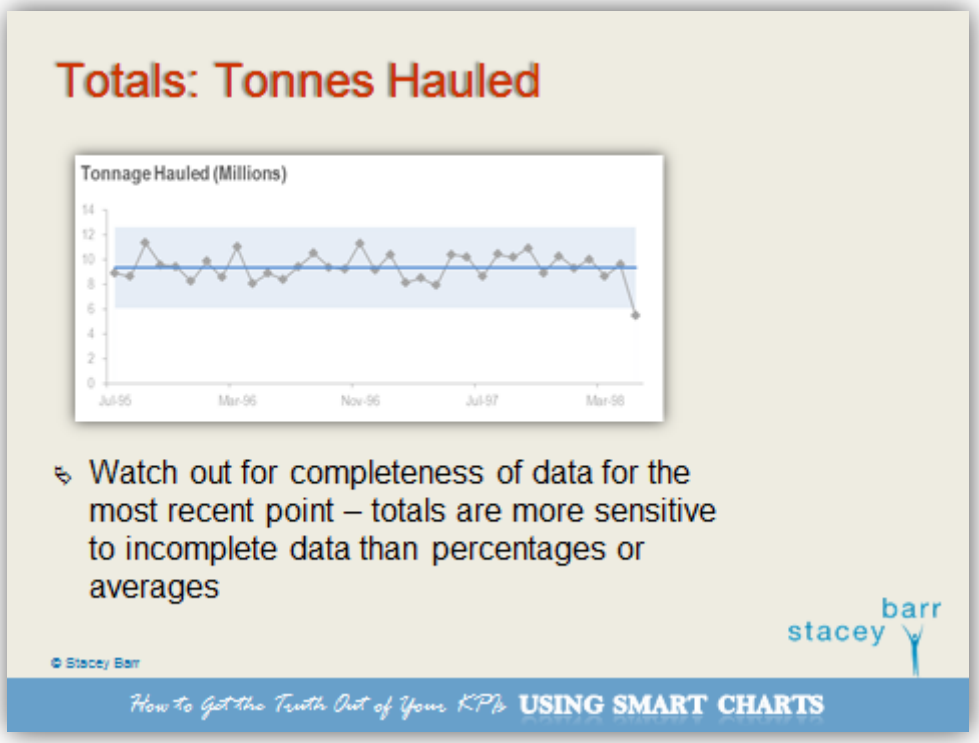

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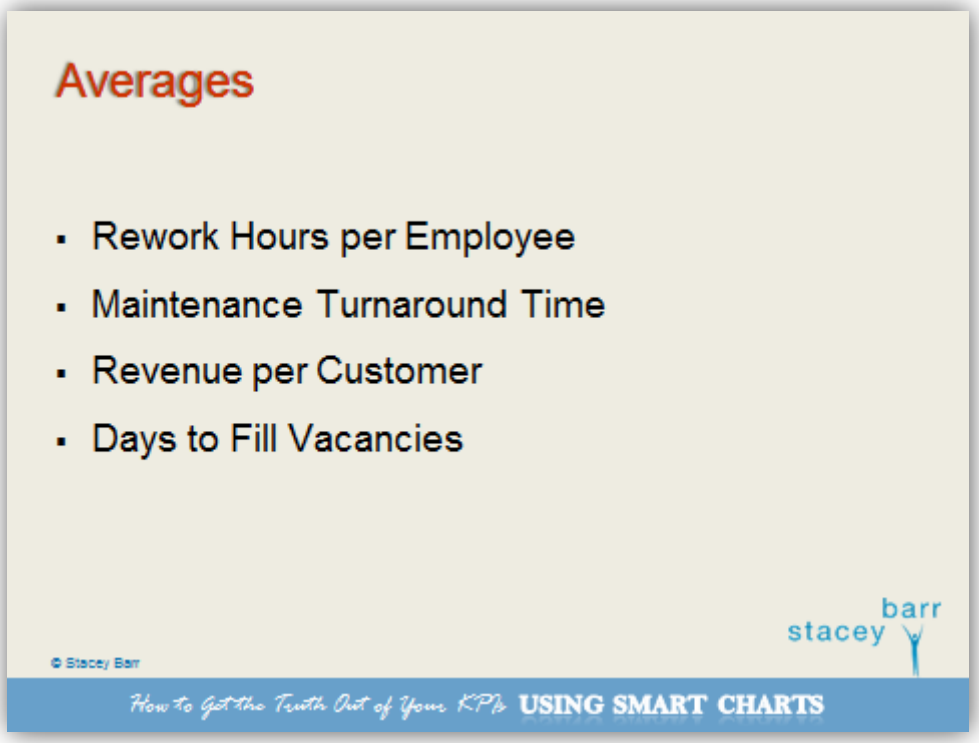

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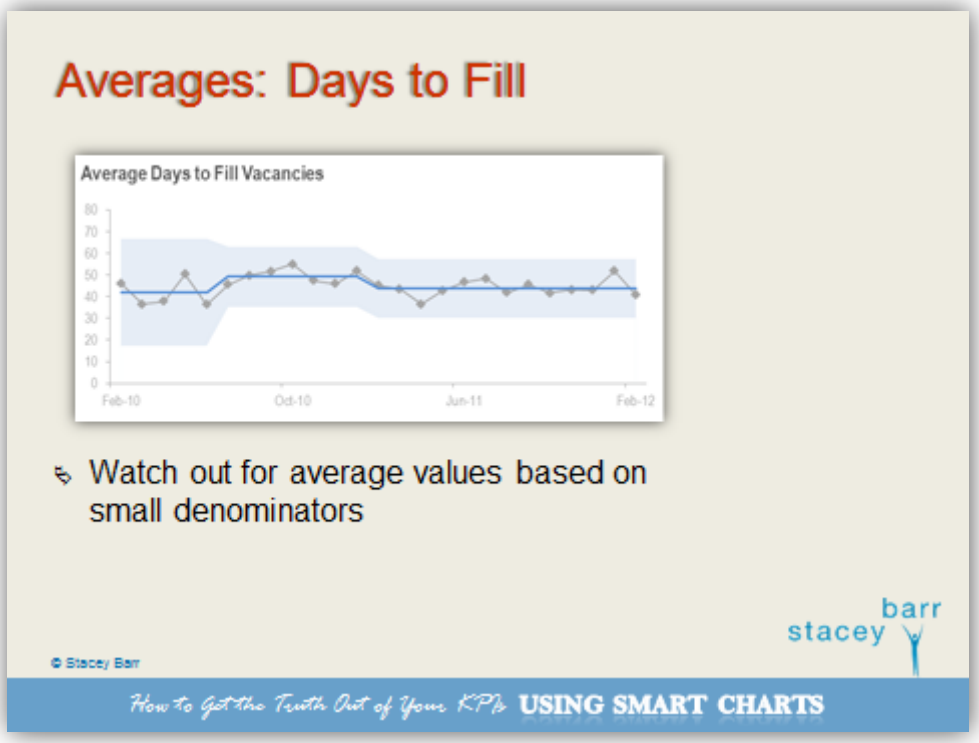

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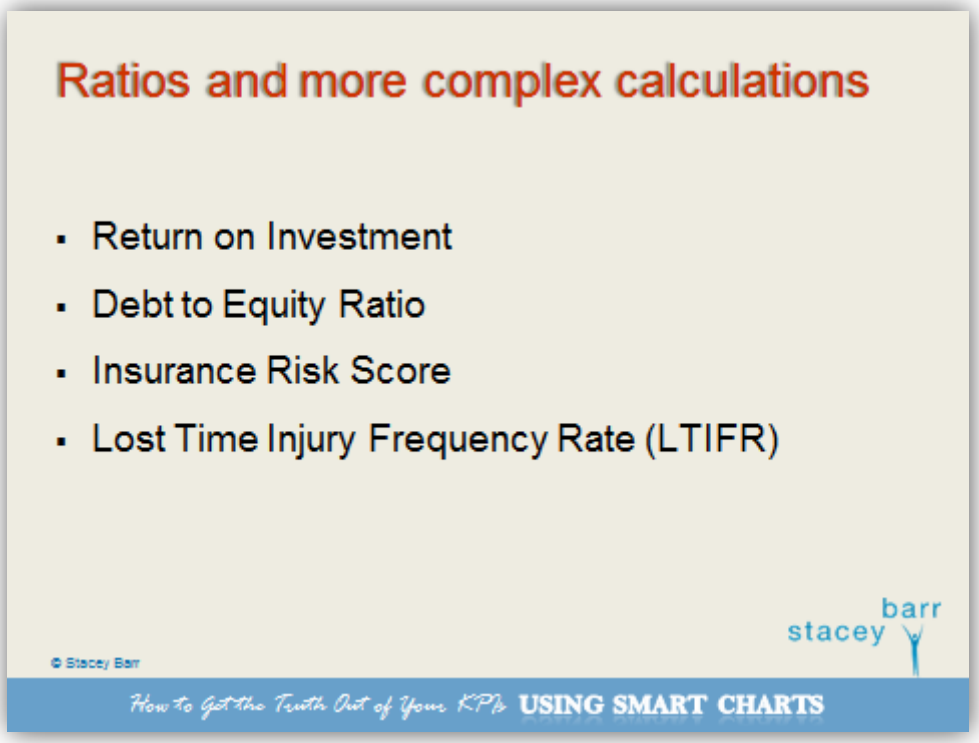

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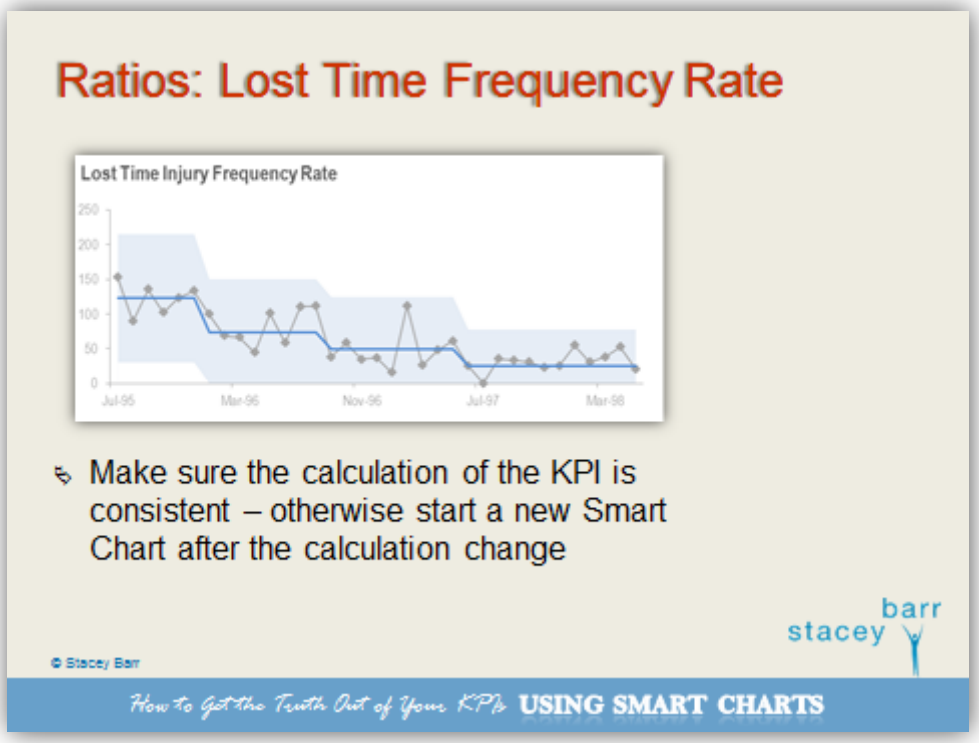

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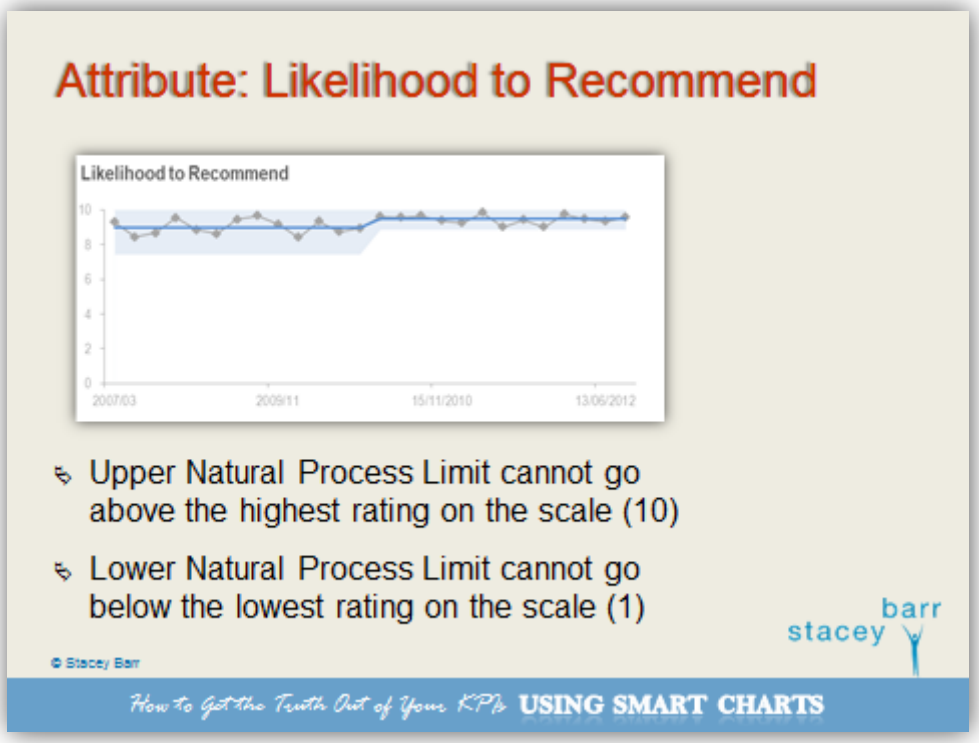

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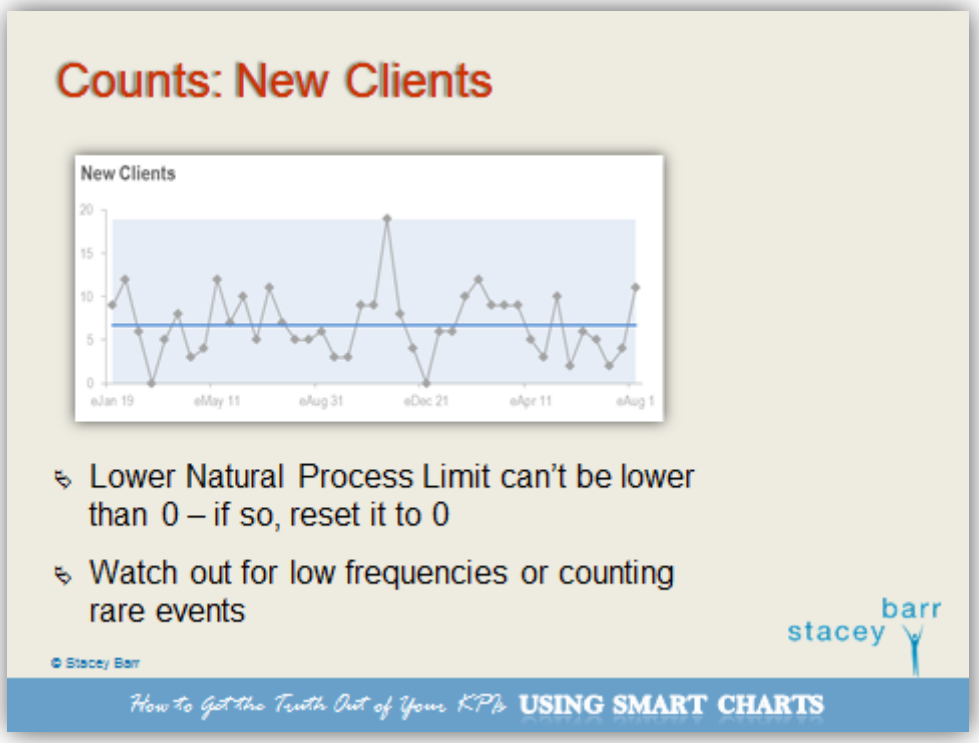

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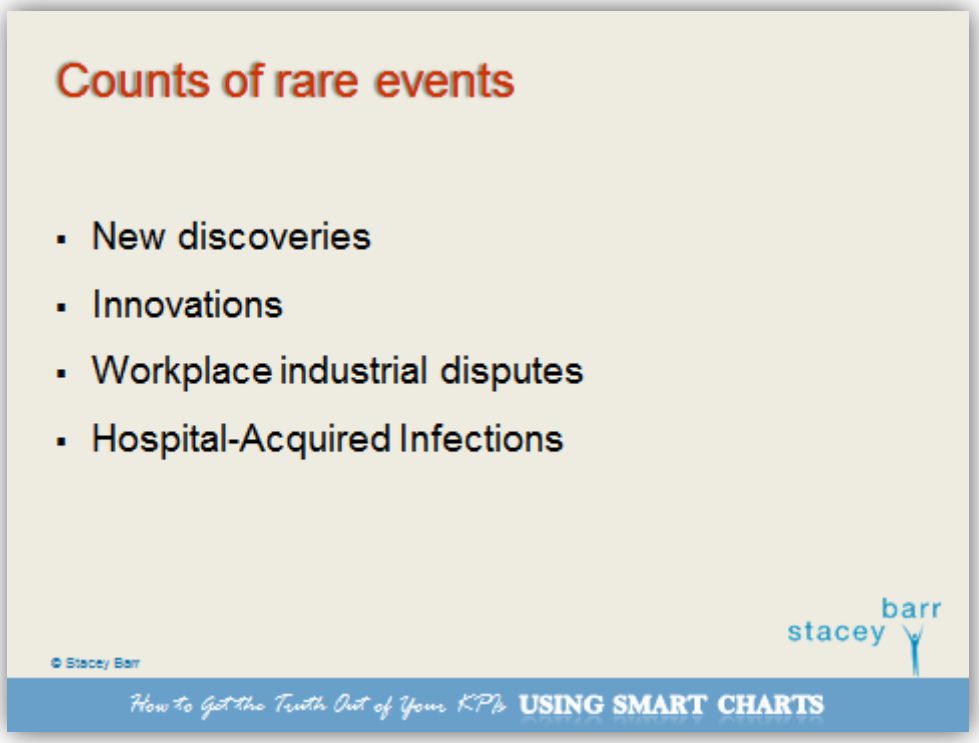

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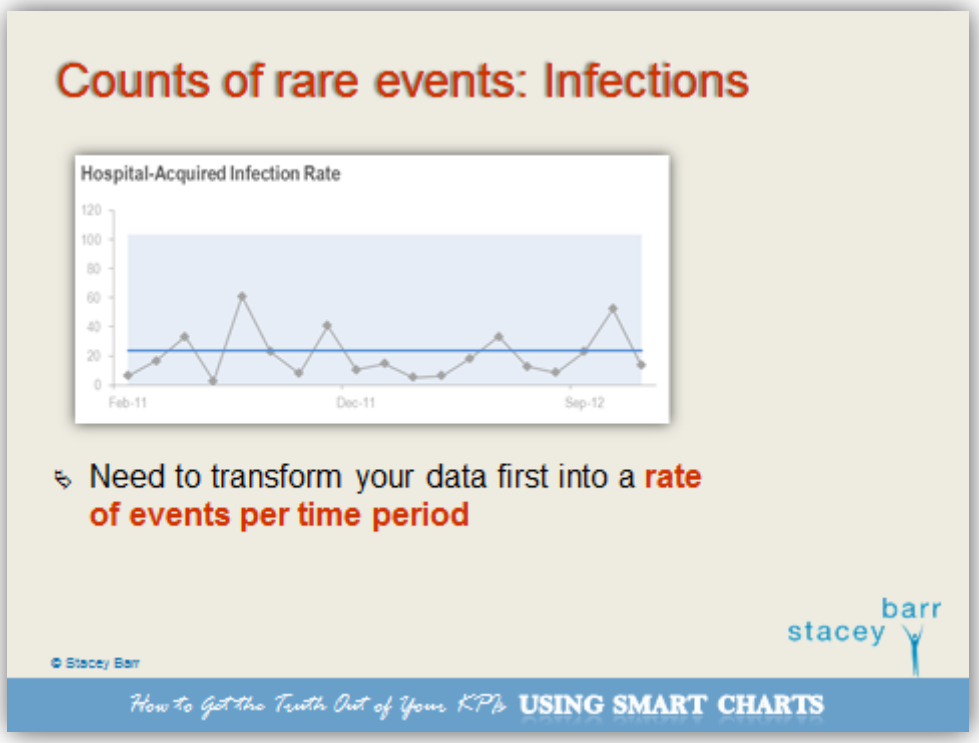

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Steps to turn rare events into rates for Smart Charts, using the template.

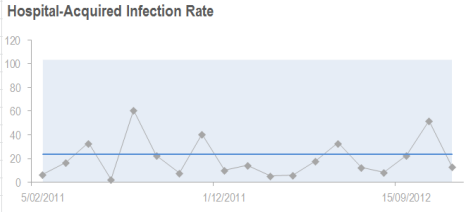
Use the the *Using Smart Charts TEMPLATE – Rare Events* spread sheet file. You'll be working first on the "Conversion to Rate" sheet to get your rare event data ready for the Smart Chart.

Here's an excerpt of how the "Conversion to Rate" sheet looks, with the sample data included:

	A	B	C	D
1	Enter your event dates here	These values are calculated automatically - just adjust the formulae here to match the range of your own data.		
2	Date of event	Days between events	Daily Rate (Events per day)	Instantaneous Rate (Events per year)
3	5/02/2011			
4	3/04/2011	57	0.018	6.404
5	25/04/2011	22	0.045	16.591
6	6/05/2011	11	0.091	33.182
7	15/09/2011	132	0.008	2.765
8	21/09/2011	6	0.167	60.833
9	7/10/2011	16	0.063	22.813
10	22/11/2011	46	0.022	7.935

You're going to then use the Instantenous Rate calculations for your Smart Chart on the "Event Rate" sheet, and that will look like this:

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Date of event	Infection Rate	Central Line	Moving Ranges	Average Moving Range	Upper Range Limit	lower Natural Process Limit	upper Natural Process Limit	target lower limit	Target Central Line	target upper limit		NOTE: you can set targets for the Central Line and/or Natural Process Limits
2	5/02/2011						0.0	103.3					NOTE: the formulae for Central Line and Natural Process Limits are in this row and the following row
3	3/04/2011	6.40	23.8				0.0	103.3					
4	25/04/2011	16.59	23.8	6.4	29.9	97.8	0.0	103.3					NOTE: the remaining rows contain links to values in the first row
5	6/05/2011	33.18	23.8	16.6	29.9	97.8	0.0	103.3					
6	15/09/2011	2.77	23.8	30.4	29.9	97.8	0.0	103.3					
7	21/09/2011	60.83	23.8	58.1	29.9	97.8	0.0	103.3					
8	7/10/2011	22.81	23.8	38.0	29.9	97.8	0.0	103.3					
9	22/11/2011	7.93	23.8	14.9	29.9	97.8	0.0	103.3					
10	1/12/2011	40.56	23.8	32.6	29.9	97.8	0.0	103.3					
11	5/01/2012	10.43	23.8	30.1	29.9	97.8	0.0	103.3					
12	30/01/2012	14.60	23.8	4.2	29.9	97.8	0.0	103.3					
13	7/04/2012	5.37	23.8	9.2	29.9	97.8	0.0	103.3					
14	4/06/2012	6.29	23.8	0.9	29.9	97.8	0.0	103.3					
15	24/06/2012	18.25	23.8	12.0	29.9	97.8	0.0	103.3					
16	5/07/2012	33.18	23.8	14.9	29.9	97.8	0.0	103.3					
17	3/08/2012	12.59	23.8	20.6	29.9	97.8	0.0	103.3					
18	15/09/2012	8.49	23.8	4.1	29.9	97.8	0.0	103.3					
19	1/10/2012	22.81	23.8	14.3	29.9	97.8	0.0	103.3					
20	8/10/2012	52.14	23.8	29.3	29.9	97.8	0.0	103.3					
21	4/11/2012	13.52	23.8	38.6	29.9	97.8	0.0	103.3					



STEP 1: Collate the dates on which the rare events occurred.

On the "Conversion to Rate" sheet in the template, collate the list of dates of your rare events in the first column, overwriting the sample data.

Stacey Barr Pty Ltd
the Performance Measure Specialist
ABN 57 129 953 635
PO Box 422 Samford
Queensland 4520 Australia
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info@staceybarr.com
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STEP 2: Calculate the number of days between events.

Again in the template, in the second column on the "Conversion to Rate" sheet, the number of days between events will be **calculated automatically**.

Notice that you won't have a value for 'number of days between events' for your first date.

The only thing you need do is check that the range of these calculations matches the range of your data in the first column. Simply delete any extra rows, or "copy down" the formula to the end of your data values.

STEP 3: Calculate the average events per day, or Daily Rate.

In the third column on the "Conversion to Rate" sheet in the template, you will notice a calculation that converts the number of days between events into the average number of events per day. This is also known as the Daily Rate.

Again, the only thing you need do is check that the range of these calculations matches the range of your data in the first column, so that you have a Daily Rate value for each of your event dates (except the first one).

STEP 4: Calculate the event rate, or Instantaneous Rate.

In the fourth column on the "Conversion to Rate" sheet in the template, the daily rates are converted into annual rates. This is done simply by multiplying the Daily Rate by 365 (for the number of days in a year). This event rate is also known as the Instantaneous Rate.

Again, check that the range of these calculations matches the range of your data in the first column, so that you have an Instantaneous Rate value for each of your event dates (again, except for the first one).

STEP 5: Construct your Smart Chart

Follow the instructions from Lesson 3 to create a Smart Chart for your Instantaneous Rate values. You can then interpret the chart as you would for any other type of performance measure, with a caveat:

CAVEAT: Is the lower Natural Process Limit negative?

It's not logical to have an Instantaneous Rate that is negative. So if your lower Natural Process Limit is calculated to be negative, it should be set to zero.

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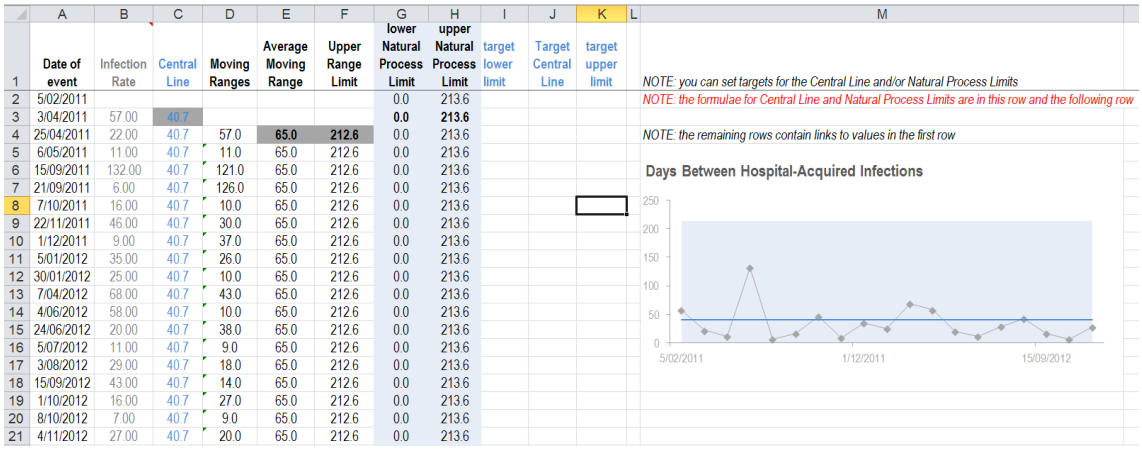
This says that you have a skewed pattern in the rates, and that affects the reliability of interpretations from the Smart Charts. Here's what to do if this happens: create another Smart Chart for the 'Days Between Events' calculations (from the second column on the "Conversion to Rate" sheet in the template). You can do this using the "Days Between Events" sheet:



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Date of event	Infection Rate	Central Line	Moving Ranges	Average Moving Range	Upper Range Limit	lower Natural Process Limit	upper Natural Process Limit	target lower limit	Target Central Line	target upper limit		NOTE: you can set targets for the Central Line and/or Natural Process Limits
2	5/02/2011						0.0	213.6					NOTE: the formulae for Central Line and Natural Process Limits are in this row and the following row
3	3/04/2011	57.00	40.7				**0.0**	**213.6**					
4	25/04/2011	22.00	40.7	57.0	65.0	212.6	0.0	213.6					NOTE: the remaining rows contain links to values in the first row
5	6/05/2011	11.00	40.7	11.0	65.0	212.6	0.0	213.6					
6	15/09/2011	132.00	40.7	121.0	65.0	212.6	0.0	213.6					
7	21/09/2011	6.00	40.7	126.0	65.0	212.6	0.0	213.6					
8	7/10/2011	16.00	40.7	10.0	65.0	212.6	0.0	213.6					
9	22/11/2011	46.00	40.7	30.0	65.0	212.6	0.0	213.6					
10	1/12/2011	9.00	40.7	37.0	65.0	212.6	0.0	213.6					
11	5/01/2012	35.00	40.7	26.0	65.0	212.6	0.0	213.6					
12	30/01/2012	25.00	40.7	10.0	65.0	212.6	0.0	213.6					
13	7/04/2012	68.00	40.7	43.0	65.0	212.6	0.0	213.6					
14	4/06/2012	58.00	40.7	10.0	65.0	212.6	0.0	213.6					
15	24/06/2012	20.00	40.7	38.0	65.0	212.6	0.0	213.6					
16	5/07/2012	11.00	40.7	9.0	65.0	212.6	0.0	213.6					
17	3/08/2012	29.00	40.7	18.0	65.0	212.6	0.0	213.6					
18	15/09/2012	43.00	40.7	14.0	65.0	212.6	0.0	213.6					
19	1/10/2012	16.00	40.7	27.0	65.0	212.6	0.0	213.6					
20	8/10/2012	7.00	40.7	9.0	65.0	212.6	0.0	213.6					
21	4/11/2012	27.00	40.7	20.0	65.0	212.6	0.0	213.6					

So now you have two Smart Charts for your rare event measure. You'll use them both, but for different purposes:

- Use the Instantaneous Rate Smart Chart to look for signals of **downward** changes (lower values).
- Use the Days Between Events Smart Chart to look for signals of **upward** changes (higher values).

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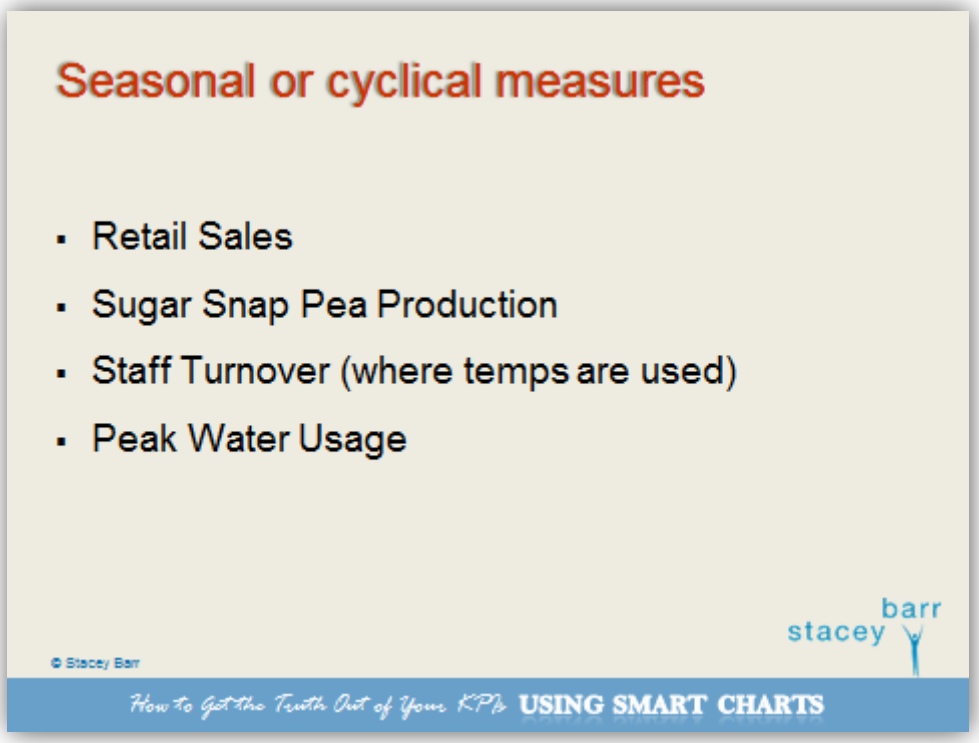

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Steps to de-seasonalise a seasonal or cyclical performance measure.

This approach to "deseasonalising" a set of performance measure values in preparation for an XmR chart (or Smart Chart) is based on Chapter 18 of Donald Wheeler's book "Making Sense of Data".

Use the the *Using Smart Charts TEMPLATE – Seasonal Data* spread sheet file. You'll be working first on the "Deseasonalising" sheet to remove the seasonal or cyclical effect from your performance measure, before you create the Smart Chart.

Here's an excerpt of how the "Deseasonalising" sheet looks, with the sample data included:

	A	B	C	D	E	F	G	H	I
1	**Month**	**Peak Day Usage - Gallons per Capita**	**Average Monthly Value**	**Seasonal Relatives**		**Month**	**Seasonal Factors**		**Deseasonalised Peak Day Usage per Capita**
2	Jul-08	41,860,000	27,260,000	1.536		Jul	1.650		25376117
3	Aug-08	44,020,000	27,260,000	1.615		Aug	1.667		26414084
4	Sep-08	33,460,000	27,260,000	1.227		Sep	1.239		27011948
5	Oct-08	25,000,000	27,260,000	0.917		Oct	0.852		29339870
6	Nov-08	18,060,000	27,260,000	0.663		Nov	0.682		26477841
7	Dec-08	19,430,000	27,260,000	0.713		Dec	0.730		26611797
8	Jan-09	17,820,000	27,260,000	0.654		Jan	0.754		23648890
9	Feb-09	18,340,000	27,260,000	0.673		Feb	0.702		26115016
10	Mar-09	18,840,000	27,260,000	0.691		Mar	0.714		26401024
11	Apr-09	21,540,000	27,260,000	0.790		Apr	0.780		27597702
12	May-09	33,040,000	27,260,000	1.212		May	1.012		32638814
13	Jun-09	35,710,000	27,260,000	1.310		Jun	1.219		29302212
14	Jul-09	44,965,810	23,035,013	1.952		TOTAL	12.000		27258902
15	Aug-09	42,490,240	23,035,013	1.845					25496155
16	Sep-09	28,112,800	23,035,013	1.220					22695203
17	Oct-09	19,079,840	23,035,013	0.828					22392001

You're going to then use the Deseasonalised calculations for your Smart Chart on the "Deseasonalised XmR" sheet, and that will look like this:

Stacey Barr Pty Ltd
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ABN 57 129 953 635
PO Box 422 Samford
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Phone: 1800 883 458
info@staceybarr.com
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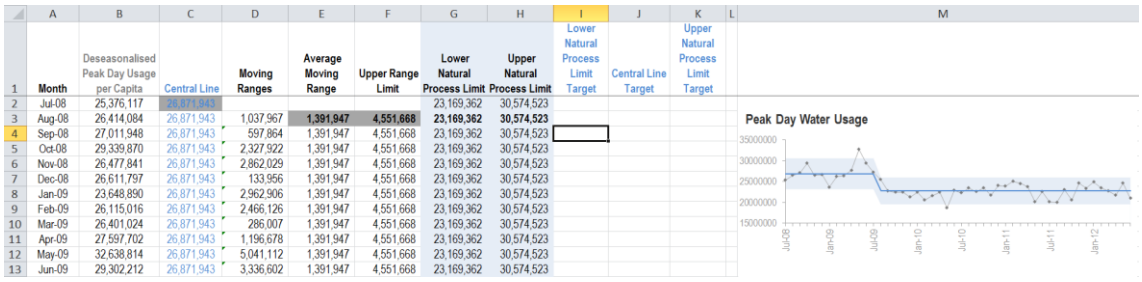

	A	B	C	D	E	F	G	H	I	J	K
1	Month	Deseasonalised Peak Day Usage per Capita	Central Line	Moving Ranges	Average Moving Range	Upper Range Limit	Lower Natural Process Limit	Upper Natural Process Limit	Lower Natural Process Limit Target	Central Line Target	Upper Natural Process Limit Target
2	Jul-08	25,376,117	26,871,943				23,169,362	30,574,523			
3	Aug-08	26,414,084	26,871,943	1,037,967	1,391,947	4,551,668	23,169,362	30,574,523			
4	Sep-08	27,011,948	26,871,943	597,864	1,391,947	4,551,668	23,169,362	30,574,523			
5	Oct-08	29,339,870	26,871,943	2,327,922	1,391,947	4,551,668	23,169,362	30,574,523			
6	Nov-08	26,477,841	26,871,943	2,862,029	1,391,947	4,551,668	23,169,362	30,574,523			
7	Dec-08	26,611,797	26,871,943	133,956	1,391,947	4,551,668	23,169,362	30,574,523			
8	Jan-09	23,648,890	26,871,943	2,962,906	1,391,947	4,551,668	23,169,362	30,574,523			
9	Feb-09	26,115,016	26,871,943	2,466,126	1,391,947	4,551,668	23,169,362	30,574,523			
10	Mar-09	26,401,024	26,871,943	286,007	1,391,947	4,551,668	23,169,362	30,574,523			
11	Apr-09	27,597,702	26,871,943	1,196,678	1,391,947	4,551,668	23,169,362	30,574,523			
12	May-09	32,638,814	26,871,943	5,041,112	1,391,947	4,551,668	23,169,362	30,574,523			
13	Jun-09	29,302,212	26,871,943	3,336,602	1,391,947	4,551,668	23,169,362	30,574,523			

STEP 1: Collate the dates and performance measure values.

You will need data for at least two periods to deseasonalise your measure. This means that if your measure has an annual repeating cycle, you need two years' worth of measure values. You can go up to about 4 or 5 years (or periods) but after that, the data is probably getting too old.

On the "Deseasonalising" sheet in the template, collate the list of dates and performance measure actual values in the first two columns, overwriting the sample data.

At this point, it is also very wise to put your measure into a simple line chart to confirm the period of the seasonality. Does a similar seasonal pattern repeat each year? Or is the pattern a quarterly cycle? This will determine the period over which you calculate the seasonal effect.

STEP 2: Determine the period of the seasonality.

At this point, it is very wise to put your measure into a simple line chart to confirm the period of the seasonality. Does a similar seasonal pattern repeat each year? Or is the pattern a quarterly cycle?

Determine the period over which you will calculate the seasonal effect.

STEP 3: Calculate the average measure value over the period of seasonality.

In the third column on the "Deseasonalising" sheet in the template, the provided calculations will automatically calculate the average measure value over a 12 month period.

If your measure's seasonal pattern is not annual, or your measure is not calculated monthly, then adjust these calculations.

Stacey Barr Pty Ltd
the Performance Measure Specialist
ABN 57 129 953 635
PO Box 422 Samford
Queensland 4520 Australia
Phone: 1800 883 458
info@staceybarr.com
www.staceybarr.com

STEP 4: Calculate the Seasonal Relatives.

In the fourth column on the "Deseasonalising" sheet in the template, a value called a Seasonal Relative is computed for each of your performance measure values. The Seasonal Relatives are a step toward calculating the seasonal effect in your measure and removing it from the measure values.

The Seasonal Relatives are calculated by dividing your measure values by their corresponding monthly average value.

STEP 5: Calculate the Seasonal Factors.

Seasonal Factors are conversion numbers that you calculate for each month in your cyclical period. So if you have an annual cycle, then you will compute a Seasonal Factor for each month of the year. If you have a quarterly cycle, you will compute a Seasonal Factor for each month in the quarter.

This all happens in the columns F and G on the "Deseasonalising" sheet in the template. The Seasonal Factor for a given month of the year is the average of all the Seasonal Relatives for that month of the year. For example, the Seasonal Factor for July is the average of all the July Seasonal Relatives.

STEP 6: Calculate the deseasonalised measure values.

To remove the seasonal effect from your actual performance measure values, you divide each measure value by the Seasonal Factor that corresponds to its month of the year.

You can see how this works in column I on the "Deseasonalising" sheet in the template spreadsheet.

STEP 7: Construct the Smart Chart for the deseasonlised values.

Follow the instructions from Lesson 3 to create a Smart Chart for your deseasonalised measure values, and interpret the chart as you would for any other measure.

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Queensland 4520 Australia
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info@staceybarr.com
www.staceybarr.com

Your notes:

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the Performance Measure Specialist
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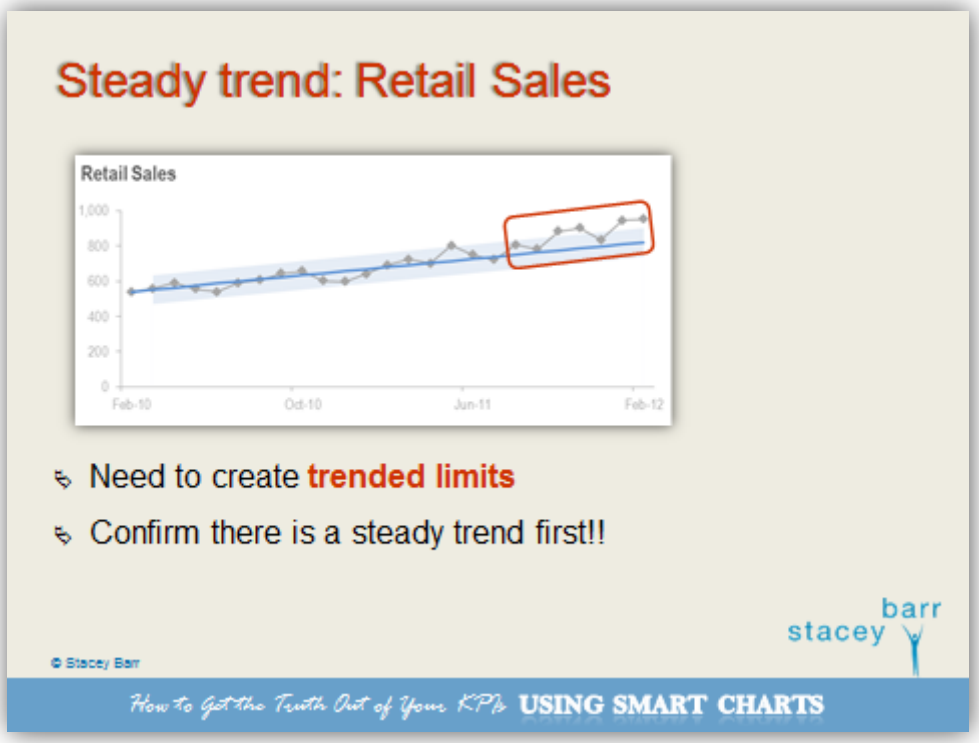

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info@staceybarr.com
www.staceybarr.com

Steps to calculate trend Central Line and Natural Process Limits

This approach to calculate a trend Central Line and Natural Process Limits for a performance measure with a steady trend, in preparation for an XmR chart (or Smart Chart), is based on Chapter 12 of Donald Wheeler's book "Making Sense of Data".

Use the the *Using Smart Charts TEMPLATE – Trend Data* spread sheet file. You'll be working first on the "Establish the trend line" sheet to estimate the trend Central Line for your performance measure, before you create the Smart Chart.

Here's an excerpt of how the "Establish the trend line" sheet looks, with the sample data included:

	A	B	C	D	E
1	**month**	**Retail Sales**	**Average of first 9 points, and second 9 points**	**Increment per time period**	**Trend Central Line**
2	Feb-10	539		11.7	540.0
3	Mar-10	558			551.7
4	Apr-10	591			563.3
5	May-10	556			575.0
6	Jun-10	540	587		586.7
7	Jul-10	590			598.3
8	Aug-10	606			610.0
9	Sep-10	643			621.7
10	Oct-10	657			633.3
11	Nov-10	602			645.0
12	Dec-10	596			656.7
13	Jan-11	640			668.3
14	Feb-11	691			680.0
15	Mar-11	723	692		691.7
16	Apr-11	701			703.3
17	May-11	802			715.0
18	Jun-11	749			726.7
19	Jul-11	721			738.3

STEP 1: Collate the dates and performance measure values.

You probably need at least a dozen performance measure values to calculate a trend Central Line and Natural Process Limits, but that said, you probaby need at least that many anyway to determine that you really do have a steady trend of growth or decline implicit in your measure.

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Queensland 4520 Australia
Phone: 1800 883 458
info@staceybarr.com
www.staceybarr.com

STEP 2: Calculate the half-averages.

The half-averages come from taking the average of your first 5 to 9 points, and also the average of the second 5 to 9 points in your measure's series of values.

These values are calculated in column C on the "Establish the trend line" sheet in the template. The half-averages are placed mid-way along the series of points used to compute them.

In the example, the first 9 points are used for the first half-average, and then the next 9 points are used for the second half-average. So the first half-average is placed next to the 5th measure value (mid-way along the first 9 points), and the second half-average is placed next to the 14th measure value (mid-way along the second 9 points).

These half-averages will be used to estimate the trend Central Line.

STEP 3: Calculate the trend increment per time period.

In the fourth column on the "Establish the trend line" sheet in the template, the increment per time period is calculated like this:

$$\frac{\text{[second half-average] – [first half-average]}}{\text{Number of points between them}}$$

In the example, the calculation would look like this:

$$\frac{[692] - [587]}{9} = 11.7$$

The increment per time period will be used to compute the values that will draw the trend Central Line.

STEP 4: Calculate the trend Central Line values.

Starting with the first half-average, you will work backwards to compute the first values for the trend Central Line by successively **taking away the increment** per time period.

Then again starting with the first half-average, you will work forward to compute the remaining values for the trend Central Line by successively **adding the increment** per time period.

This all happens in column E. The formulae are set up to do this automatically.

Stacey Barr Pty Ltd
the Performance Measure Specialist
ABN 57 129 953 635
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Queensland 4520 Australia
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info@staceybarr.com
www.staceybarr.com

STEP 5: Construct the Smart Chart for the steady trend values.

Follow the instructions from Lesson 3 to create a Smart Chart for your trend measure values. All you are doing is adding in the new trend Cental Line values and the Natural Process Limits will automatically be computed either side of this trend Central Line.

Then interpret the chart as you would for any other measure.

If you find a signal that requires you to compute new trend limits, wait until you have at least 10 points, 5 for the first half-average and 5 for the second half-average.

Beware that the trend may not continue, and you may find that it is more sensible to go back to the standard horizontal calculations for the Central Line.

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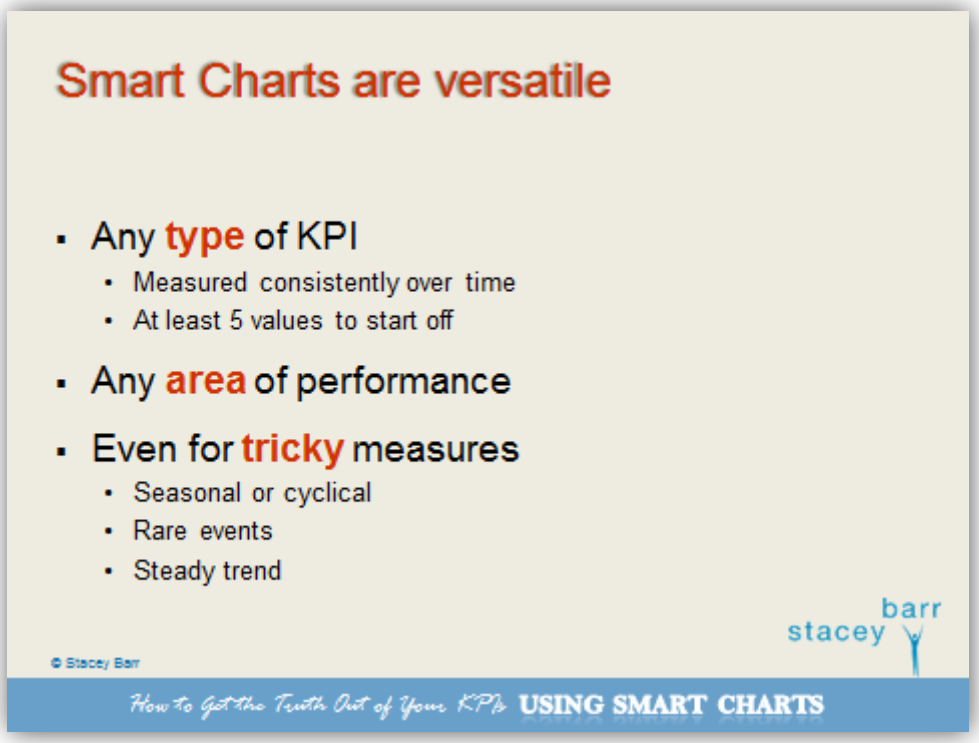

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