Service Quality Research/13

Identifying Common Cause and Special Cause Variations

By Chuck Chakrapani

Common Cause and Special Cause Variations

In the last article, we discussed the variations that arise in any system. We identified two components of variation: Common cause variations that can be attributed to the system itself and special cause variations that can be attributed to the individual functioning within that system. We discussed further how common cause variations can be of any magnitude.

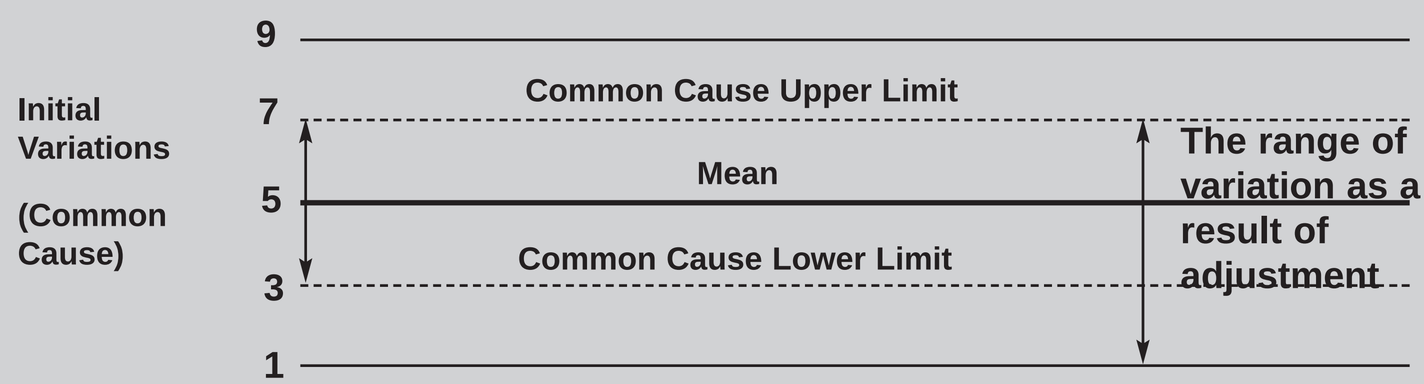
we cannot arbitrarily make an employee responsible for performance that is below some arbitrary figure such as 20% - common cause variations can be much higher or much lower than the arbitrary target set by management.

What Happens When Common Cause Variations Are Treated As Special Cause Variations?

Suppose management ignores common cause variations and treats every variation from the standard as arising out of special causes. Further suppose that management tries to ‘fine tune’ the employee’s behaviour. even though it is within the limits of common cause variations. Then what happens? The simple answer to this question is that the variability in performance will *increase*.

In other words, when management attempts to control quality when the behaviour is within control limits, the behaviour will *deviate even more* from the standard.

Exhibit 1. The Effect of Tampering With a Table System



The Effects of Tampering With a Stable System

Let us consider a given operation which should ideally take about 5 minutes to complete and an employee who performs it in 7 minutes. The additional time could have been the result of common cause variations, special cause variations or both.

Let us further assume that the average time for that employee is only 5 minutes but the additional two minutes came about due to common cause variations.

If management assumes all variations are due to special causes and the two additional minutes are something to be ‘corrected’ or fine--tuned’, then that is akin to shifting the mean around which variations occur. If common cause variations occurred with the band 5±2 minutes, by lowering the mean, the variations will be 3±2 minutes. The total variation then will range from a low of 1 (3-2) to a high of 7 (5+2), instead of the original range of 3 to 7 (5±2). Constant fine tuning will introduce so much variation into the system that it will destroy consistency and hence quality. This is illustrated in Exhibit 1 above.

Since the limits of variations cannot be set arbitrarily, unless these variations are measured, quality enhancement programmes that ignore the two components of variation stand a very good chance of creating an effect that is completely opposite to the desired effect.

Identifying Common Cause Variations

It then becomes imperative to identify common cause variations. Once identified we can work on the two specific components of quality enhancement - the system and the individual.

Identifying common cause variations is a fairly simple task. It consists of simply plotting the figures on a graph and making a few minor statistical calculations. Let us consider the 'research data' similar to the one we used the last time to illustrate the performance of two departments (Exhibits 2 and 3). As in our earlier example, Department II appeared to show a poorer performance record.

Exhibit 2. Performance of Department I

	Week					
	1	**2**	**3**	**4**	**5**	**Total**
A	15	13	17s	14	12	71
B	167w	13	13	18s	10	70
C	13	15	13	10	15	66
D	16w	13	14	13	13	69
E	19s	18s	12	15	13	77
F	10	12	16w	13	12	63
G	16w	14	15	15	12	72
H	18s	15	10	7s	12	72
I	15	18s	15	4	11	73
J	13	14	18s	5	12	72
Ave.	**15.1**	**14.5**	**14.3**	**14.4**	**12.2**	**73**

(W: Employee warned; S: Employee severely warned)

Exhibit 3. Performance of Department II

	Week					
	1	**2**	**3**	**4**	**5**	**Total**
A	13	19s	19s	10	17s	78
B	16w	18s	16w	15	14	79
C	18s	12	11	12	16	69
D	16w	18s	12	16w	19s	81
E	17s	15	15	12	16w	75
F	11	11	17s	16w	19s	74
G	12	12	11	18s	12	65
H	16w	11	13	18s	19s	77
I	16w	12	14	11	13	66
J	17S	18	14	18	17S	84
Ave.	**15.2**	**14.6**	**14.2**	**14.6**	**16.2**	**75**

The data can be plotted on graph paper, ignoring individuals. This is shown in Exhibit 4 for both departments. The plot also shows the Lower Control Limit (LCL) and the Upper Control Limit (UCL) for each set of data. Details of calculations are given below:

1.The mean of the series is plotted by calculating the total of all observations divided by the number of observations multiplied by the number of employees.Thus for Department I:

$$\bar{x} = 730 \div (5 \times 10) = 14.6$$

and for Department II:

$\bar{x}$ = 750 ÷ (5 x 10) = 15.0

2. Calculate the proportions as follows:

$\bar{p}$ = $\bar{x}$ / (Observation size)

(If we assume that the above scores are the number of minor errors made by each employee out of 100 transactions, then 100 is the observation size.)

For department I:

$\bar{p}$ = 14.6 / 100 = 0.15

For department II:

$\bar{p}$ = 15.0 / 100 = 0.15

3. Set the lower and upper control limits using the following formula:

$$LCL = \bar{x} - 3\sqrt{\bar{x}(1-\bar{p})}$$

$$LCL = \bar{x} + 3\sqrt{\bar{x}(1-\bar{p})}$$

Thus the LCL and UCL for Department I are:

LCL = 4.1
UCL = 25.1

the LCL and UCL for Department II are:

LCL = 4.2
UCL = 25.8

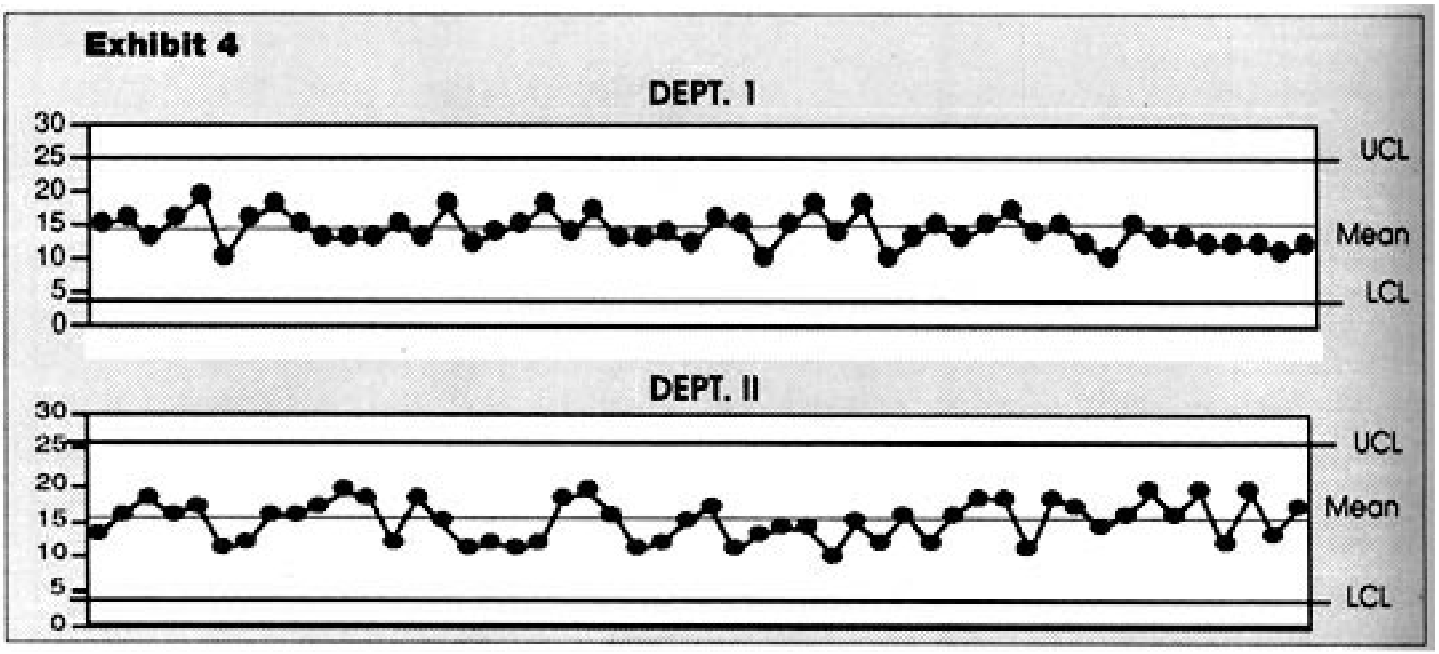
When we initially looked at the data for the first time, it looked as though Department I showed consistent improvement and Department II was a relatively poor performer with potentially less efficient employees. But when we plot the control limits we see that both departments are operating within control limits and there is no evidence of special causes.

The main implication of this identification of common cause variations is that if quality has to be improved, the system is to be analysed as a whole. Because there is no evidence of special cause variations, adjusting employee behaviour (under the threat of punishment or rewards) is more likely to increase the variation in performance and make it worse than it was before.

The basic message is that when the sources of variations are not understood and employees are rewarded or punished according to some pre-determined performance measure, it is likely to *increase* variation in performance and result in lower rather than higher quality.

Two Components of Quality

Quality has two facets: Variability and Level. However, management tends to concentrate on *level* of service rather than on *variability*.



Variability

Variability is essentially unsettling to most customers. A courier who would definitely deliver your package out-of-town in 48 hours is preferable to another who could deliver after 24 hours, 48 hours or 72 hours in an inconsistent fashion. Even if the second courier on average delivers your package faster, the first courier will be considered of higher quality because of their consistency.

Variability also has another advantage. To reduce variability, the system needs to be standardized. Such standardization decreases cost by increasing employee efficiency. Another benefit is that it makes it easier to train new employees when procedures are standardized and well-defined.

When the system is highly variable, it is difficult to make any improvement to the level of service. Even if we made some improvement, it is hard for customers to notice.

Again, consider two local courier services. Courier A promises that all packages will be delivered in four hours and does deliver them as promised. Courier B has an average delivery time of only 3-1/2 hours, but the actual time varies - delivery could be anywhere between 1 to 16 hours.

Now, if Courier A cuts the delivery time by 30 minutes, it will be noticeable. Conceivably, it will also be easier for Courier A to do it since lower variability indicates control over the system.

On the other hand, if Courier B cuts the delivery time by 30 minutes, it will be difficult for the customers to notice since, when performance is inconsistent, *average time* is an abstract construct for most customers. It is also a reasonable assumption that high variability implies lack of control over the system and it is considerably more difficult to improve a system over which one has little control.

When we find that all variability is generated by the system what do we mean by that and how do we ‘improve the system’?

As we saw in earlier examples, any result produced by an employee that is not under his or her direct control can be construed as having been produced by the system within which the employee operates. As an example, consider the counter personnel in a bank who are required to get the signature of an officer for all transactions in excess of $200. This adds time to the transaction and, since counter personnel have no control over the number of such transactions, the additional time element can be viewed as having been generated by the system. The best solution in such cases is not to exhort the employees to be more efficient or reward and punish them for their supposed efficiency but to find ways of streamlining the operations on hand

One of the points repeatedly made by Deming is that management rushes to reward and punish its employees as the sole means to improving quality; and they wonder why quality has not improved or has gone down. Deming contends that in a large number of cases employees are already doing their best and it is managements' responsibility to understand the system. Many organizations do not achieve their ideal of better quality because they are manipulating the wrong variables - employees rather than the system that constrains them. In a large majority of cases, Deming contends that reward and punishment has deleterious effects on quality enhancement.

Level

Once the variability is brought under control, it is relatively straightforward to improve the level. To control variability in a system requires an understanding of the factors that affect it. Once variability is brought under control, the knowledge that enabled us to do that can be applied to improve the level.

In our example of reducing service time variability, we could increase the dollar limit (if that is possible) for obtaining the signature of the officer. If we succeed in reducing variability as a result, we can make it faster by giving more officers signing authority or streamlining some other part of the system.

In Short

I would like to emphasize that following points:

1. Reducing variability is fundamental to improving quality.
2. In a vast number of cases this can be achieved by manipulating the system rather than the employees.
3. The main reason that many organizations fail to achieve quality is that they concentrate on level rather than on variability and on employee performance rather than on the constraints of the system.