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The Impact on Quality of Multiple Supplier Systems

by John J. Flaig, Ph.D.

If you subscribe to Quality Engineering you might what to check out an article of mine that appears in Vol. 14, No. 3. entitled, “The Quality Implications of Increasing the Number of Suppliers”. It deals with the perennial issue of bringing on a second, third, fourth, etc., supplier. I say perennial because every time I discuss this issue with people outside the Quality domain they always have their own strong opinions about what to do and many favor having multiple suppliers. This belief is based not on data but on an intuitive feeling that having more suppliers reduces risk (e.g., they often comment -- what happens if the supplier’s plant burns down?). So let’s see if analytical tools can be used to reach a scientific conclusion instead of relying on gut feel to manage our business.

In this simplification of the problem we are only going to consider a product with a single quality characteristic. Now, as part of the supplier qualification process the buyer has previously received samples of the product from supplier S_2 and found that they are “just as good” as the primary supplier S_1. Here “just as good” means that μ_2 is near μ_1, and σ_2 is near σ_1. For example, assume μ_2 comes from $N(\mu_1, e_1)$ where e_1 is some positive constant. The standard deviation σ_2 is estimated from the second supplier’s qualification samples and is assumed to be distributed as $N(\sigma_1, e_2)$ where e_2 is some positive constant. The simulation method generated 10,000 values at random from $N(\mu_1, \sigma_1)$. The value for μ_2 was drawn at random from $N(\mu_1, \sigma_1)$, and a value for σ_2 was drawn at random from $N(\sigma_1, \sigma_1/4)$. Then 10,000 values were generated at random from $N(\mu_2, \sigma_2)$. The two samples of ten thousand were then combined and compared with the specification limits.

This Monte Carlo simulation study of 20,000 cases (with the quantity purchased divided equally) was repeated thirty times using $\mu_1 = 10$, $\sigma_1 = 1$, μ_2 is selected from N(10, 1), σ_2 is selected from N(1, .25), USL = 13, and LSL = 7 with the result that if samples are randomly drawn from each supplier’s characteristic distribution, then the probability that the nonconformance rate (expressed in defectives per million (DPM)) increases is:

$$P(DPM(S_1 \cup S_2) > DPM(S_1)) \approx .75$$

This result may seem surprising because the second supplier's variation is, on average, the same as the first, so one might think that the combined distribution would be no worse. The simulation shows that this intuitive notion is false because variations in both the mean and standard deviation of the second supplier combine to adversely affect the nonconformance rate. Also, note that this analysis reflects a product with a single characteristic. If the product has n independent characteristics each with specifications as given above, then

$$P(DPM(S_1 \cup S_2) > DPM(S_1)) \approx 1 - .25^n$$

Hence, $P(DPM\uparrow) \approx .94$ for $n = 2$, and $P(DPM\uparrow) \approx .98$ for $n = 3$. Realistically, most products have multiple characteristics and thus the probability that nonconformances will increase is essentially certain (i.e., $P(DPM(S_1 \cup S_2) > DPM(S_1)) \to 1$ as $n \to \infty$).

Which brings us to our conclusion – Dr. Deming was right! Multiple supplier systems will tend to degrade product quality. So, the answer to the question about the plant burning down is that the expected losses sustained from a multiple supplier system will typically out weigh the benefits accrued from such a system.

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