Assignment 1 : Quality Improvement & DMAIC

1. What is quality planning? Quality assurance? quality control and improvement?

   Quality planning:

   - strategic activity, and it is vital to an organization ’ s long term business success as the product development plan, the financial plan, the marketing plan, and the utilization of human resources
   - involves identifying customers, both external and those that operate internal to the business, and identifying their needs
   - then products or services that meet or exceed customer expectations must be developed

   Quality assurance:

   - the set of activities that ensures the quality levels of products and services are properly maintained and that supplier and customer quality issues are properly resolved
   - Quality system documentation involves four components: policy, procedures, work instructions and specifications, and records.
   - development, maintenance, and control of documentation are important quality assurance functions.

   Quality control and improvement:

   - the set of activities used to ensure that the products and services meet requirements and are improved on a continuous basis
   - statistical techniques, including SPC and designed experiments, are the major tools of quality control and improvement
   - Quality improvement is often done on a project-by-project basis

2. What is meant by the cost of quality?

   Prevention costs:

   - associated with efforts in design and manufacturing that are directed toward the prevention of non-conformance

   Appraisal costs:

   - associated with measuring, evaluating, or auditing products, components and purchased materials to ensure conformance to the standards

   Internal Failure costs:

- costs incur when products, component, materials, and services fail to meet quality requirements. Failure is discovered prior to delivery to customers

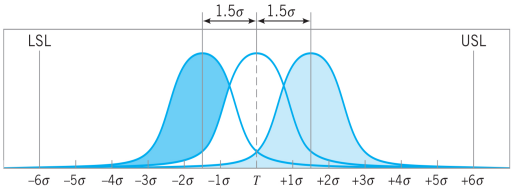
External Failure costs:

- costs occur when the product does not perform satisfactory after it is delivered to customers

3. What are the purpose of tollgate reviews?

- to ensure the project is on track
- to evaluate whether can successfully complete the project on schedule
- present a guidance regarding the use of specific technical tools and other information about the problem
- identify problems and deal with barriers

4. Suppose that a process is currently operating at 3.5 sigma level of quality, and it is planned to use projects to move this process to a 6 sigma level. What project improvement rate would be necessary to achieve that new performance in 2 years?



Spec. Limit	Percentage inside specs	ppm Defective
±1 Sigma	30.23	697700
±2 Sigma	69.13	608700
±3 Sigma	93.32	66810
±4 Sigma	99.3790	6210
±5 Sigma	99.97670	233
±6 Sigma	99.999660	3.4

(*b*) Normal distribution with the mean shifted by ±1.5σ from the target

Figure 1: normal distribution

$$(\text{NORM.S.DIST}(-1, \text{TRUE})) \times 1000000 = 158655.2539$$
$$(\text{1-NORM.S.DIST}(5, \text{TRUE})) \times 1000000 = 0.286651572$$
$$3.4 = 158656 \times (1-x)^2$$
$$3.4/158656 = (1-x)^2$$
$$ln(3.4/158656) = 2ln(1-x)$$
$$2 = ln(3.4/158656)/ln(1-x)$$
Thus, the improvement rate $= x = 0.99537 \approx 0.9954$

5. Derive the mean and variance of the Binomial distribution.

   Proof the mean $E(X) = np$

$$
\begin{aligned}
E(X) &= \sum_{x=0}^{\infty} x\, p(x) \\
&= \sum_{x=0}^{\infty} x\, C_x^n\, p^x\, q^{n-x} \\
&= \sum_{x=0}^{\infty} x\, \frac{n!}{x!(n-x)!}\, p^x\, q^{n-x} \\
&= \sum_{x=1}^{\infty} \frac{np\,(n-1)!}{(x-1)!(n-x)!}\, p^{x-1}\, q^{n-x} \\
&= \sum_{x=1}^{\infty} np\, C_{x-1}^{n-1}\, p^{x-1}\, q^{n-x} \\
&= np \sum_{x=1}^{\infty} C_{x-1}^{n-1}\, p^{x-1}\, q^{n-x} \\
&= np
\end{aligned}
$$

   Proof the variance $E(X^2) - E(X)^2 = npq$

   since $E(X^2) - E(X)^2 = E[X(X-1)] + E(X) - E(X)^2$

$$
\begin{aligned}
E[X(X-1)] &= \sum_{x=0}^{\infty} x(x-1)\, p(x) \\
&= \sum_{x=0}^{\infty} x(x-1)\, C_x^n\, p^x\, q^{n-x} \\
&= \sum_{x=0}^{\infty} x(x-1)\, \frac{n!}{x!(n-x)!}\, p^x\, q^{n-x} \\
&= \sum_{x=2}^{\infty} \frac{n!}{(x-2)!(n-x)!}\, p^x\, q^{n-x} \\
&= \sum_{x=2}^{\infty} \frac{n(n-1)p^2(n-2)!}{(x-2)!(n-x)!}\, p^{x-2}\, q^{n-x} \\
&= \sum_{x=2}^{\infty} n(n-1)p^2\, C_{x-2}^{n-2}\, p^{x-2}\, q^{n-x} \\
&= n(n-1)p^2 \sum_{x=2}^{\infty} C_{x-2}^{n-2}\, p^{x-2}\, q^{n-x} \\
&= n(n-1)p^2
\end{aligned}
$$

   Thus, $E(X^2) - E(X)^2 = n(n-1)p^2 + np - np^2 = np(1-p) = npq$