# Process Capability Assessment Based on Bayesian Approach

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## Abstract

The purpose of process capability analysis is to provide numerical measures for determine whether a process is capable of reproducing items meeting the manufacturing specifications, which have received considerable research attention and increased usage in process assessments and purchasing decisions. Most existing research works on capability analysis have focused on the traditional distribution frequency approach. However, the sampling distributions are usually so complicated, this makes establishing the exact confidence interval very difficult. Cheng and Spiring (1989) proposed a Bayesian procedure for assessing process capability index $C_p$. Chan *et al.* (1988) applied a similar Bayesian approach to index $C_{pm}$ under the assumption that the process mean $\mu$ is equal to the target value $T$. However, the restriction of $\mu = T$ is not a practical assumption for most factory applications. Shiau *et al.* (1999a) developed a Bayesian approach to index $C_{pm}$ without the restriction on the process mean and index $C_{pk}$ but under the restriction that the process mean $\mu$ equals to the midpoint of the two specification limits, $M$. We note that in this case $C_{pk}$ will reduce to $C_p$. In this dissertation, we first consider a Bayesian procedure for the capability index $C_{pk}$ relaxing the restriction. The posterior probability, $p$, for which the process under investigation is capable, is derived. For processes with unilateral specifications, an accordingly Bayesian procedure for capability testing based on the one-sided indices $C_{PU}$ and $C_{PL}$, is obtained. For applications where a routine-based data collection plans are implemented, a common practice on process control is to estimate the process capability by analyzing past "in control" data. Unfortunately, statistical properties of those PCI estimators based on one single sample, have been investigated extensively, but not for multiple samples. To use estimators based on multiple samples and then interpret the results as if they were based on a single sample may result in incorrect conclusions. Therefore, the manufacturing information regarding product quality characteristic should be derived from multiple samples rather than one single sample. In this dissertation we further consider the problem of estimating and testing $C_p$, $C_{pk}$, $C_{PU}$, $C_{PL}$ and $C_{pm}$ with multiple samples based on Bayesian approach. The results obtained for $C_p$ and $C_{pm}$ with multiple samples in our investigation, are generalizations of those obtained in Cheng and Spiring (1989) and Shiau *et al.* (1999a) from one single sample case to multiple samples case based on control chart data. Practitioners can easily use the proposed procedure to determine whether their manufacturing processes are capable of reproducing products satisfying the preset capability requirement.

**Keywords:** *Bayesian approach; Credible interval; Distribution frequency approach; Fraction nonconforming; Multiple samples; Posterior probability; Process capability indices*