Generalized Confidence Intervals for Assessing Process Performance based on Quality Yield Index

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Abstract

In recent years, technology has improved dramatically, and consumers' demands for quality have become higher. Therefore, many scholars have investigated in designing advanced process capability indices for measuring the process performance with extremely low defect rate. Process yield is a commonly used tool in manufacturing industry to evaluate process performance. However, process yield only consider if the product falls within the specification limits and assume the products which meet the specification limits have the same quality. To remedy for this situation, a more advanced and customer-orientated index, called quality yield index (Y_q), was proposed. Quality yield index takes quality loss into consideration by penalizing yield when the product characteristic deviates from the target value. Unfortunately, the sampling distribution of the estimated Y_q is too complicated, which makes it difficult to establish the exact confidence interval. Therefore, several approaches for constructing confidence intervals of the index Y_q have been presented including approximate distribution approach (AD) and bootstrap approach. Approximate distribution method is constructed by subtracting the upper bound of expected relative process loss from the lower bound of process yield and can also be view as a conservative estimation method. Bootstrap method is a useful technique for estimating sampling distribution no matter what the exact population distribution is. In this paper, we apply the concept of generalized pivotal quantities to construct the generalized confidence interval (GCI) for Y_q. In order to examine the performance of GCI method, a series of simulations are conducted and compared with the existing methods in terms of coverage rate and the average value of lower confidence bound (LCB). The simulation results indicate that GCI method always performs the best for calculating LCB of Y_q. As a result, the GCI method is recommended in practical situations for assessing the process performance based on the quality yield index.

Keywords
Generalized confidence interval, Lower confidence bound, Process capability indices, Quality yield, Simulation

Biographies

Meng Tzu Lin is currently a graduate student master in the Department of Industrial Engineering and Engineering Management at National Tsing Hua University (NTHU). She is also the current class representative. Miss Lin received her B.S. degree in Industrial Engineering and Engineering Management from National Tsing Hua University (NTHU) in 2018. Her major research fields are quality management, statistical process control, process capability index and process capability analysis, which includes various sampling plans, normal and non-normal process capability indicators, methods for constructing indicator confidence intervals, etc.

Chien-Wei Wu is currently a Professor in the Department of Industrial Engineering and Engineering Management at National Tsing Hua University (NTHU), Taiwan. Dr. Wu received his Ph.D. degree in Industrial Engineering and Management with Outstanding Ph.D. Student Award from National Chiao Tung University in 2004 and the M.S. degree in Statistics from NTHU in 2002. He is serving as one of Editors-in-Chief of Quality Technology and Quantitative Management (QTQM) and editorial board members for various international journals. His research interests include quality engineering and management, statistical process control, process capability analysis and data analysis.