# ABSTRACT

Control chart is a powerful tool in process monitoring and its improvement. The basic methodology of control chart consists of taking samples at certain time intervals and plotting an appropriate statistic. Too frequent sampling leads to extra cost. Too less monitoring leads to quality problems. Economically designed control charts provide the remedy for this problem. Despite the benefits reported in literature, use of economic control charts is less in practice. Apart from the mathematical complexity in the economic designs, the problems with these designs can be described in two categories.

1. The problems with regard to the non-availability of the precise estimates of the cost and process parameters for the economic design of the control charts.
2. The problems with regard to the operation of the control chart, due to lack of good statistical properties.

Accurate estimation of cost and process parameters is a difficult task There is a need to develop more precise estimation methods from the available data and also to make the control chart designs robust to the impreciseness in the estimates of cost and process parameters. Economic control chart designs may cause frequent false alarms or delay in recognizing the adverse changes occurring in the process during operation. These are the operational problems with economic designs. By incorporating constraints on the statistical properties of the control chart, these problems can be reduced. Present work aims at developing mathematical models to estimate the process failure rate from the data available from the control charts and to design an economic $\bar{X}$ control chart when the cost and process parameters are not known with certainty. Incorporating the statistical constraints is considered in the proposed design methodology.

Mathematical models to estimate the process failure rate from the control chart cycle times for exponential, Weibull and gamma process failure mechanisms have been developed. To facilitate the calculations, tables have been prepared for obtaining the process failure rates for exponential process, for specified shift parameters and the mean control chart cycle times. The process failure rate is one of the input parameters required in the economic design model. This parameter has the ability to recognize the improvement in the process and can also be used to compare two similar processes.

Moreover, the process failure rate plays an important role in converting a multiple assignable cause model to a matched single assignable cause model. This justifies the emphasis on failure rate estimation among the numerous input parameters.

A robust economic control chart design procedure has been developed using the concept of risk. Because of the uncertainty in the input parameters, in place of point estimates, use of interval estimates is suggested in the economic design model. The main advantage of this method is that it does not require the assumption of a statistical distribution for the parameters within their intervals. Since it is very difficult to obtain accurate distributions for all parameters in real situations, this methodology provides better practical solutions and induces confidence in the application of control charts. The design procedure is based on the principle of minimization of maximum risk, which is simple to understand. Initially, the robust economic design procedure is introduced for a single parameter variation and has been extended to multiple parameter variation. Genetic algorithm based search has been used to find the best solution in the case of multiple parameter variation. Statistical constraints are incorporated in the proposed design methodology.

The solutions obtained using the present risk-based design methodology have been compared with the robust economic designs of Pignatiello and Tsai model. Finally, the robust economic design methods are studied for simplifying the existing procedures. A simple method for robust economic control chart design has been suggested for a process with multiple scenarios. The risk-based design procedure has been simplified to provide approximate solutions with less computational burden.

Key Words: $\bar{X}$ Control chart, Control chart cycle time, Process failure mechanism, Exponential distribution, Weibull distribution, Gamma distribution, Robust Economic designs, Risk-based design, Single parameter variation, Multiple parameter variation, Genetic algorithm.