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Optimal Parameters of Double Moving Average Control Chart

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Abstract — The objective of this paper is to present explicit analytical formulas for evaluating characteristics of Double Moving Average control chart (DMA) for Poisson distribution. The most popular characteristic of a control chart are Average Run Length (ARL_0) – the mean of observations that are taken before a system is signaled to be out-of control when it is actually still in control, and Average Delay time (ARL_1) – mean delay of true alarm times. An important property required of ARL_0 – mean delay of true alarm times. An important property required of ARL_0 is that it should be sufficiently large when the process is in-control to reduce a number of false alarms. On the other side, if the process is actually out-of control then ARL_1 should be as small as possible. In particular, the explicit analytical formulas for evaluating ARL_0 and ARL_1 be able to get a set of optimal parameters which depend on a width of the moving average (w) and width of control limit (H) for designing DMA chart with minimum of ARL_1

Keywords — Optimal parameters, Average Run Length, Average Delay time, Double Moving Average chart.

I. INTRODUCTION

CONTROL chart is an effective tool in statistical process control for detecting changes in a process, and uses for measuring, controlling and improving quality in many areas of interest including finance and economics, medicine, sociology, engineering, and others. Attribute control charts are important technique in SPC to monitor the discrete data. When the quality characteristic cannot be measured on a continuous scale, for instance, in counting the number of defective products or the number of nonconformities in a production process, an attribute control chart must be used. Commonly used attribute control chart are p, np, c, and u charts. Additionally, Exponentially Weighted Moving Average (EWMA) and Cumulative Sum (CUSUM) charts for attribute data have also been applied to discrete processes (see, e.g., Page [1], Alwan [2]). Recently, the Moving Average control chart (MA) first has studied for monitoring the non-conforming or defective fraction in discrete processes by Khoo [3]). Later, Double Moving Average chart (DMA) was extended by Khoo and Wong [4] with moving average of the MA statistic one more time. They proposed this chart with normal observations and also showed the numerical simulations of ARL. According to Khoo and Wong [4], the performance of the DMA chart is superior to the MA, EWMA and CUSUM charts for monitoring small and moderate shift for process mean. Furthermore, the explicit formulas for computing the ARL_0 and ARL_1 when the weighted moving average (w) equal to 1 and 2 were proposed by Areepong and Sukparungsee [5]. Consequently, the explicit formulas of ARL_0 and ARL_1 for DMA chart with arbitrary the values of w when observations are binomial distribution also submitted in Sukparungsee and Areepong [6]. In this paper, the explicit analytical formulas for evaluating ARL_0 and ARL_1 DMA chart for Poisson distribution and a set of optimal parameters which depend on a width of the moving average (w) and width of control limit (H) for designing DMA chart with minimum of ARL_1 are presented.

II. CONTROL CHARTS AND THEIR PROPERTIES

We consider SPC charts under the assumption that sequential observations $X_1, X_2 ...$ of some process are identical independently distributed random variables with a distribution function $F(x,\alpha)$, where α is a control parameter. It is assumed that $\alpha = \alpha_0$ while the process is in-control and $\alpha = \alpha_1 > \alpha_0$ when the process goes out-of control. It is assumed that there is a change-point time $\theta \leq \infty$ at which the parameter changes from $\alpha = \alpha_0$ to $\alpha = \alpha_1$ Note that $\theta = \infty$ means that process always remains in the in-control state.

All popular charts, such as Shewhart, Cumulative Sum (CUSUM) and EWMA charts are based on some function of parameter values that is used as a criterion for a process to go "out-of-control" if this function value goes above an upper control limit (UCL) or below a lower control limit (LCL). The minimum time required for a chart to signal out-of –control is defined as the stopping (alarm) time τ.

Let $E_\theta(.)$ denote the expectation that the change-point from $\alpha = \alpha_0$ to $\alpha = \alpha_1$ for a distribution function $F(x,\alpha)$ occurs at time θ, where $\theta \leq \infty$. In the literature on quality