New Quality Control Chart to Quickly Detect the Changes of Process Average

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Abstract

The objective of this article is to propose a new control chart—improved exponentially weighted moving average (IEWMA) control chart—to fast detect the mean shifts of process when quality characteristic data are normally distributed. This chart still has robust property even though its controls limits are created from data with outliers. The efficiency inspection of IEWMA control chart is managed 504 situations for the simulation data. Moreover, the four control charts, namely, exponentially weighted moving average (EWMA), robust exponentially weighted moving average (REWMA), median mean absolute deviation (MDMAD), and average control charts, are compared the performances with IEWMA control chart. All charts are constructed by using data set in two cases, i.e., the first case that data are not include outliers and the second case that data are composed of outliers. It is found that in the case of non-outliers in the data, the three charts—IEWMA, EWMA and REWMA control charts—tend to have the most capability for process average shift detection for all sample sizes and all levels of the process average changes. For the case of outliers in the data, the IEWMA control chart tends to have the most efficiency for all sample sizes, especially for the tiny process shifts from the target.

Keywords: *control chart, exponentially weight, moving average, normal distribution, outliers, process mean*

1. Introduction

Generally, qualities of the manufactured products in industrial production process are required to achieve or overcome the customer expectations. Moreover, the fundamental goals of production are to achieve the target mean of the process and to control the variation of product quality to be minimum level. The variation of industrial production process can be occurred all the time, no matter how the production process well designed or controlled. This variation is influenced by various factors that both controllable and uncontrollable factors, for example, it may be caused by using non-standard tools or using the wrong types of tools, the machine may deteriorate, the workers do not have production skills, the qualities of raw materials in the production process are lower qualities than specified levels, etc. These factors will affect the product quality. That is, if products in the production process have a small variation, it will result in the quality of each manufactured product being not much different quality. However, if products in the production process have a large variation, it will affect the product quality that does not achieve the product standards. In the industrial production process often encounter problems that products that do not meet the specified standards. One of the main reasons is the process average to be controlled has changed, but the process operators may be unaware of this change. Thus, if they allow production to continue resulting in non-standard products coming out of the process. These problems have the detrimental effect on the factory which may experience loss or damage the reputation of the factory when those inferior products are distributed to the consumers. The quality control chart is one of the most popular tools for statistical process control to warn the manufacturers that the current production process has changed from a predetermined one. This makes it possible to quickly resolve quality issues when manufacturing malfunctions occur. If the chart is regularly analyzed in the production process, it helps to ensure consistent product quality and reduce variation in the manufacturing process. The idea of statistical control chart was first introduced by Shewhart (Montgomery, 2012), e.g., average control chart was devised under the assumption that data are normally distributed. This average control chart is generally utilized in quality control processes because it is easy to understand by the operators and it is not a complicated tool. However, several researches are shown that the average control chart is poor effective tool to detect abnormal process in cases of the small process mean shifts from the target (Abu-Shawiesh, 2009; Wang, 2009; Huang, Tai and Lu, 2014; Chew et al., 2015; Shafqat et al., 2020; Alevizakos, Chatterjee and Koukouvinos, 2021). After that, there are many fast response control charts that to be better than the average control chart for detection the slight mean shifts were proposed as follows: in 1959, the exponentially weighted moving average control chart or EWMA control chart was proposed by using the weighted mean of all past and current observations for monitoring the process (Roberts, 2000). Therefore, this chart is very effective for the slight process shifts (Lucas and Saccucci, 1990; Knoth, 2005; Khoo and Sim, 2006; Montgomery, 2012; Shamsuzzaman and Wu, 2012; Şentürk et al., 2014; Chakraborti and Graham, 2019; Hesamian, Akbari and Ranjbar, 2019; Mitra, Lee and Chakraborti, 2019). In 1982, cumulative sum control chart was developed by using the property of fast initial response (FIR) and this research was found that it perform well at the outset of the anomalous process (Lucas and Crosier, 1982). Later, the same FIR feature was used to develop EWMA control chart and it has a good performance in detecting of process mean