



Contribution ID: 108

Type: not specified

## Multivariate Statistical Process Control for Real-time Monitoring on Count Data

*Tuesday, 28 June 2022 10:10 (20 minutes)*

In the pharmaceutical industry, production environments are being monitored for bacterial contamination (i.e., so-called environmental monitoring). The industry is currently investigating the usefulness of real-time monitoring using a particle counter (like the BioTrak). Such an instrument continuously “inhales” air and reports the number of viable organisms in different particle size intervals per small period (every 30 minutes). Monitoring these multivariate count data is not straightforward since the underlying joint distribution of the count data is typically unknown, complicating the choice or selection of a control chart for multivariate count data that have been developed over the years for different applications and distributional assumptions. In recent years, an exact Poisson control chart was developed for a specific multivariate Poisson distribution, while the Hotelling  $T^2$  control chart for multivariate normal distributions was proposed as an alternative for the exact Poisson control chart. The np and generalized p-charts were developed for multinomial count data, while a copula-based control chart was offered for over- and underdispersed count data. Finally, the likelihood ratio test was proposed for monitoring discretized data. This study comprehensively compares the average run length (ARL) of all these different control charts using simulations under various distributional assumptions. The goal is to determine which of these charts is most robust or generically appropriate when their underlying distributional assumptions are being violated. We simulated multivariate count data that mimic environmental monitoring and do not satisfy the underlying distributions to make a fair comparison. We also demonstrate these control charts on a real data set from environmental monitoring using the BioTrak instrument.

### Keywords

control chart, multivariate count data, real-time monitoring.

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**Session Classification:** CONTRIBUTED Quality 3

**Track Classification:** Quality