**The effects of large round off errors on the performance of control charts for the mean**

Benson-Karhi Diamanta[[1]](#footnote-1)\*1, Ben-David Michal1,2, Levi Ofer1, Schechtman Edna2

1Department of Mathematics and Computer Science, the Open University of Israel,

P.O.B. 808, Raanana 43107, Israel

2Department of Industrial Engineering and Management, Ben-Gurion University of the Negev, P.O.B. 653, Beer-Sheva 84105, Israel

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 **ABSTRACT**

This research discusses the effects of large round-off errors on the performance of control charts for the means when the process is normally distributed with a known variance and a fixed sample size.

Quality Control practice uses control chart for means, developed by Shewhart in 1924, as a process monitoring tool, even when the data is significantly rounded. The objective of this research is to demonstrate the damage to the quality control of a measured process caused by ignoring the round-off errors and using the standard Shewhart chart.

Sometimes it is known that there is round-off measurement error generated by the measurement instrument. The scale step of the measurement instrument (h) is defined by the difference between two consecutive values of the measurement instrument and is assumed to be known. The magnitude of the rounding (denoted by δ) is determined by the ratio between the process standard deviation () to the instrument's scale step (h), i.e.,$δ=\frac{σ}{h}$, effects the calculations and the statistical analysis. Round-off is considered large when $δ$ is lower than 0.5. In these cases, using the standard control charts may be incorrect and misleading in detecting shifts in process quality-characteristics.

The first part of the research includes theoretical calculations for estimating the values of alpha, beta, ARL0 and ARL1, relating to the unrounded data and the large-rounded data. For the rounded data, it is incorrect to assume normality because the data is discrete, therefore the multinomial distribution was used. Results show that under the null hypothesis (H0), alpha and ARL0 indicate that false alarms were significantly more frequent. Under the alternative hypothesis (H1), the influence on beta and ARL1 is minor and inconsistent. For some rounding levels there is a decrease in the control chart performances and in others there is an improvement in the control charts performances. In addition, a simulation model helped estimating the performances of the control chart for a single sample, checking whether the average of a certain sample is between the control limits when the numbers are rounded and when they are not rounded. The results of the simulation match the theoretical calculations.

***Key Words:***

 ***Average Run Length (ARL), Control Chart, Control Limits, Large Round-Off, Measurement Error, Round-Off Error***

# 1. INTRODUCTION

1. \* Corres.: Diamanta Benson-Karhi, Department of Mathematics and Computer Science, the Open University of Israel . diamanta@openu.ac.il [↑](#footnote-ref-1)