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WIDE CIRCULATION DRAFT

BUREAU OF INDIAN STANDARDS
(DRAFT FOR COMMENTS ONLY)

Control charts —
Part 6: EWMA control charts for the process mean
(First Revision)

ICS 03.120.30

Statistical Methods for Quality , Data Analytics and Reliability, Sectional Committee, MSD 3	**Last Date for receipt of Comments is November 2024**

NATIONAL FOREWORD

(Formal clauses to be added later on)

This standard was previously published in 2018 which was identical with ISO 7870-6: 2016. The first revision of this standard has been undertaken to align it with the latest version of ISO 7870-6: 2024.

This Indian Standard is published in several parts. The other parts in this series are:

Part 0 Guidelines for selection of control charts
Part 1 Control charts for variables
Part 2 Control charts for attributes
Part 3 Specialized control charts
Part 4 Cumulative Sum Charts
Part 5 Acceptance control charts
Part 7 Multivariate control charts
Part 8 Charting techniques for short runs and small mixed batches
Part 9 Control charts for stationary processes

The text of the International Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appear referring to this standard, they should be read as `Indian Standard’.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of analysis shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (second revision)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

In this adopted standard, reference appears to an International Standard for which Indian Standard also exists. The correspondence Indian standard, which is to be substituted in its place, is listed below along with degree of equivalent for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 3534-2, Statistics — Vocabulary and symbols — Part 2: Applied statistics	IS 7920 (Part 2):2012/ ISO 3534-2:2006, Statistics - Vocabulary and symbols: Part 2 applied statistics (Third Revision)	Identical

Annexes A, B and C are for information only.

Note: The technical content of the document is not available on website. For details, please refer the corresponding ISO 7870-6: 2024 or kindly contact:

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Scope

This document covers EWMA control charts, originally proposed by Roberts (1959)[16], as a statistical process control technique to detect small shifts in the process mean. It makes possible the faster detection of small to moderate shifts in the process mean. In this chart, the process mean is evaluated in terms of exponentially weighted moving average of all previous observations or averages.

The EWMA control chart's application is worthwhile in particular when

- production rate is slow,
- a minor or moderate shift in the process mean is vital to be detected,
- sampling and inspection procedure is complex and time consuming,
- testing is expensive, and
- it involves safety risks.

NOTE EWMA control charts are applicable for both variables and attributes data. The given examples illustrate both types (see 5.5, Annex A, Annex B and Annex C).

Introduction

Shewhart control charts are the most widespread statistical control methods used for controlling a process, but they are slow in signalling shifts of small magnitude in the process parameters. The exponentially weighted moving average[13] (EWMA) control chart makes possible faster detection of small to moderate shifts.

The Shewhart control chart is simple to implement and it rapidly detects shifts of major magnitude. However, it is fairly ineffective for detecting shifts of small or moderate magnitude. It happens quite often that the shift of the process is slow and progressive (in case of continuous processes in particular); this shift has to be detected very early in order to react before the process deviates seriously from its target value. There are two possibilities for improving the effectiveness of the Shewhart control charts with respect to small and moderate shifts.

- The simplest, but not the most economical possibility is to increase the subgroup size. This may not always be possible due to low production rate; time consuming or too costly testing. As a result, it may not be possible to draw samples of size more than 1.
- The second possibility is to take into account the results preceding the control under way in order to try to detect the existence of a shift in the production process. The Shewhart control chart takes into account only the information contained in the last sample observation and it ignores any information given by the entire sequence of points. This feature makes the Shewhart control chart relatively insensitive to small process shifts. Its effectiveness can be improved by taking into account the former results.

Where it is desired to detect slow, progressive shifts, it is preferable to use specific charts which take into account the past data and which are effective with a moderate control cost. Two very effective alternatives to the Shewhart control chart in such situations are

a) Cumulative sum (CUSUM) control chart. This chart is described in ISO 7870-4. The CUSUM control chart reacts more sensitively than the X-bar chart to a shift of the mean value in the range of half to two sigma. If one plots the cumulative sum of deviations of successive averages from a specified target, even minor, permanent shifts in the process mean will eventually lead to a sizable cumulative sum of deviations. Thus, this chart is particularly well-suited for detecting such small permanent shifts that may go undetected when using the X-bar chart.
b) Exponentially weighted moving average (EWMA) control chart which is covered by this document. This chart is presented like the Shewhart control chart; however, instead of placing on the chart the successive averages of the samples, one monitors a weighted average of the current average and of the previous averages.

EWMA control charts are generally used for detecting small shifts in the process mean. They will detect shifts of half sigma to two sigma much faster. They are, however, slower in detecting large shifts in the process mean. EWMA control charts can also be preferred when the subgroups are of size $n = 1$.

The joint use of an EWMA control chart with a small value of smoothing parameter (λ) and a Shewhart control chart has been recommended as a means of guaranteeing fast detection of both small and large shifts. The here considered EWMA control chart monitors only the process mean; monitoring the process variability requires the use of some other technique including special EWMA control charts.

The numbers in all tables and figures were calculated using the R-package SPC, (Knoth 2022), which makes use of the algorithm proposed by Crowder (1987).

The R-file containing the calculations can be downloaded on https://standards.iso.org/iso/7870/-6/ed-2/en.