Chapter 1

Introduction

Statistical process control (SPC) is the collection of methods for recognizing special causes and bringing a process into a state of control and reducing variation about a target value. Statistical process control is a sector of statistics dealing with the effort of improving quality constantly. It uses many tools in order to achieve this goal. The first of them were introduced in 1920's (Shewhart charts). SPC is extensively used in industry to keep manufacturing processes under control. The need of monitoring specific processes led to its great development and improvement. Its tools are used in various fields of science such as industry, medicine, environment, economics, text analyses and informatics.

The most valuable tool of SPC is control charts. These charts give a graphical appearance of the process giving the ability to any manager with or without the knowledge of statistics to immediately understand if the process is under control or not. The wide use and popularity of control charts is a result of many reasons. First of all their proven ability to improve productivity, because the reduction of scrap and rework results in an increase of productivity, increase in production capacity measured in the number of good parts per hour and decrease in cost. Their effective prevention of defect items is also valuable. The use of control charts helps to keep the process under control. Finally, the diagnostic information of control charts is significant as it allows for changes in the

process by experienced operators or engineers.

The research in the area of control charts is active for over eight decades now. Although someone would expect that there would be a decreasing interest in this area after all these years, we observe exactly the opposite. There is an increasing interest for this tool since it has proved its value in practice. Most of the deficiencies of control charts are under investigation and at the same time new problems need a solution in the quality field by the use of control charts. This thesis aims to investigate some of the characteristics of control charts and tries to give solutions to quality problems.

The outline of the thesis is the following. In Chapter 2, a review of the most known univariate and multivariate control charts is presented. The control charts presented are the Shewhart type for variables and attributes in both univariate and multivariate cases and the Cumulative Sum (CUSUM) and Exponentially Weighted Moving Average (EWMA) charts again for the univariate and multivariate cases. The main properties of these charts are also given. Chapter 3 deals with the estimation effect on control charts. A detailed review of the current status of the subject is given in the univariate and multivariate cases. Some new results on the estimation effect of the univariate control charts for dispersion are also presented. Chapter 4 considers the issue of non-normality in-control charts. The effect of non-normality on the univariate and multivariate Shewhart and EWMA control charts is presented. Additionally, new results are given in the case of the EWMA control charts for process dispersion under the presence of non-normality. Chapter 5 investigates the problem of interpreting a signal on a multivariate control chart. Several researchers have dealt with this problem and their results are presented. A new proposal for a chart that addresses this problem is given that is proved to have promising results. Measurement error effect on control charts is the subject of Chapter 6. The presence of measurement error is a factor that may affect the performance of a control chart. The different considerations of authors in the context of Shewhart control charts are outlined. The effect of such a problem in the EWMA case is examined thoroughly under the assumption of a specific model. Finally, in Chapter 7 some final thoughts

and discussion for possible future research issues and generalizations are given for the different subjects that have been addressed in this thesis.