# Statistical Process Control Charts: Bibliometric Analysis of Publications in Brazil

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## Abstract

This paper contains a bibliometric analysis of articles related to control charts in Brazil. The choice of this theme is relevant because the search for improving the quality of products, services and processes has been steady. To study the national scene in Brazil, the basis of the research was the Scientific Electronic Library Online (SciELO) and other important journals in the area of engineering. This database was chosen because it provides literature written in Portuguese and Spanish, in addition to well-defined entry standardsand criteria and permanence of scientific journals. The period set for the evaluation was from 2001 to 2014. During this period, the publications in the multivariate control chart area are limited to the period after 2005, which indicates that this area of study is still little explored in the country. The articles were also analyzed for their application. They were divided into four groups: Agribusiness: publications that used data for fields, crops or technologies used in rural areas; Study: articles related to theoretical analysis, proofs, interpretations and use of the proposed control charts; Industry: those that used data collected from industrial processes and case studies; Other: any scientific publication related to the subject that does not fit in the previous three areas. Through this breakdown, one can see that agribusiness is developing in the area of univariate control charts in similar proportion to industry. On the other hand, multivariate control charts are more prevalent in the area of theoretical study, which shows an area of development in this segment.

Keywords: Multivariate charts; Bibliometric analysis; Statistical Process Control.

## 1. Introduction

The analysis process of a particular scientific production theme is a fundamental process to ensure investments in the area and understand its evolution over the period considered. These analyses are based primarily on two methods: qualitative evaluation - which considers comparison between articles and the reputation of the object evaluated - and quantitative evaluation - based on bibliometric and scientometric methods. (Vanz & Stumpf,2010).

This research is defined as a bibliometric analysis of articles related to control charts in Brazil. This analysis, in turn, consists of a quantitative and qualitative assessment in relation to items of a particular topic, through the choice of sources (magazines and journals) and standardized forms of searching (Pereira; Souza & Lunkes, 2013).

The choice of this theme is relevant because the search for improving the quality of products, services and processes has been steady. There are several tools for these purposes, among them SPC (Statistical Process Control).

Scientific production that references control charts was subdivided into two groups: univariate and multivariate control charts. This research analyzed both groups to discuss the issue of the development of this subject in Brazil. Thus, one can divide the process adopted into the following steps: definition of keywords; setting the sources to be searched; organization of data and further analysis.

## 2 METHODOLOGICAL PROCEDURES

To study the national scenario in Brazil, the keywords defined were limited to the Portuguese language and are presented in Table 1. The keywords defined were: Statistical Process Control, Control Charts, Multivariate Control Chart, Hotelling $T^2$, MCUSUM (Multivariate Cumulative Sum Control Chart) and MEWMA (Multivariate Exponentially Weighted Moving Average Chart). The research sources used were the Scientific Electronic Library Online (SciELO) and the following periodicals: *Pesquisa & Desenvolvimento Engenharia de Produção*; *Produção Online*; *Produto & Produção*; *Revista GEPROS*; *Revista Gestão Industrial* and *Sistemas & Gestão*.

SciELO was chosen as a source because it provides literature written in Portuguese and Spanish, in addition to well-defined entry standards and criteria and permanence of scientific journals. According to the magazine *Pesquisa FAPESP* (2002), the SciELO program was developed in partnership with the Latin American and Caribbean Center for Information in Health Sciences (Bireme) and the support of the National Scientific and Technological Development Council (CNPq) and brings together more than 90 newspapers and journals produced in Brazil and Latin America. Since the scope of the paper is to discuss the Brazilian scenario in the area, the choice of SciELO and national journals in the field of production and industrial engineering was the most suitable, since they represent some of the biggest national publications.
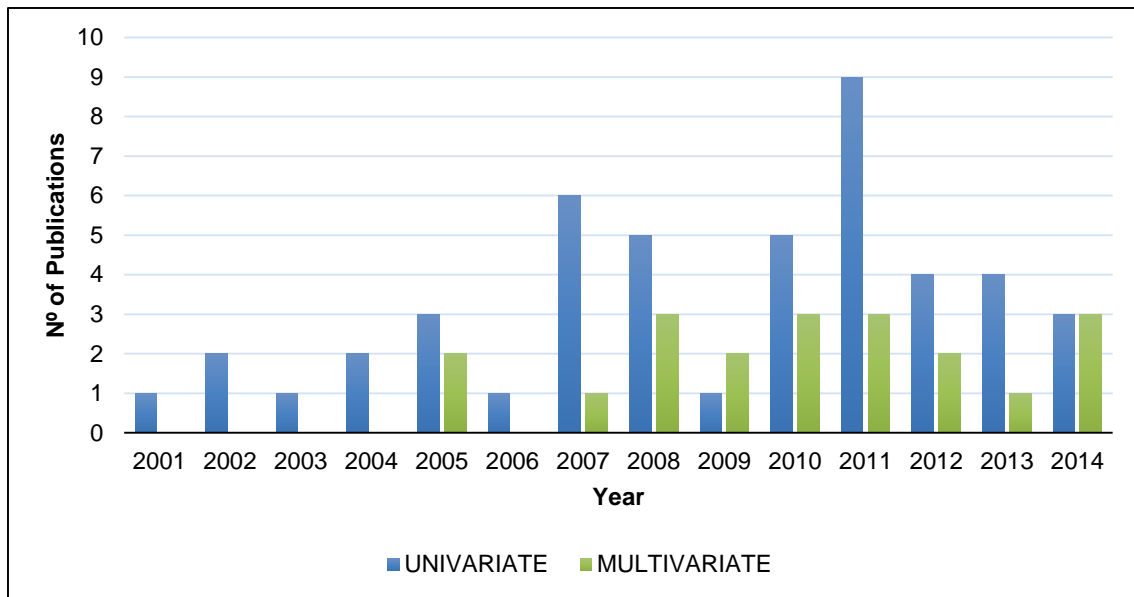
## 2 BIBLIOMETRIC REVIEW

Given the selection of articles, 24 journals and periodicals, of which 18 belonged to SciELO, were analyzed in all. Of the articles checked and found to be relevant to the subject of the research, 47 were found on control charts and 20 relating to multivariate control charts.

The period set for the evaluation was 2001-2014 and the distribution of the publications can be seen in Figure 1. During this period, articles on multivariate control charts were published in Brazil starting only in 2005, which indicates how this area of study can be further explored in the country.
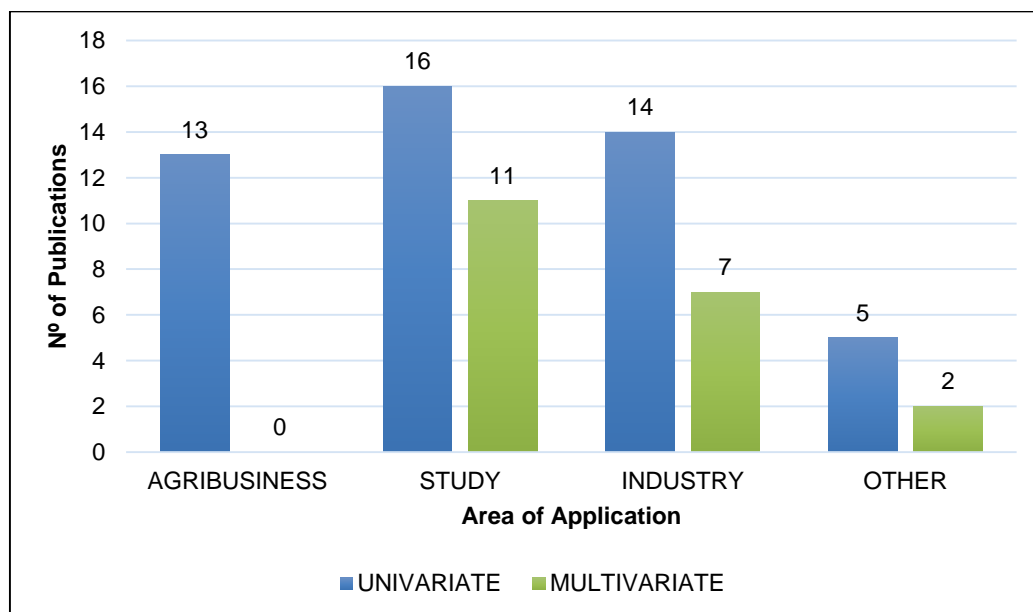
Still, it is possible to verify that the longest period of publications about univariate control charts occurred from 2007 to 2011. As quality control instruments within the manufacturing process, it can be noted that the global economic crisis in 2007-2009 may have boosted the study and application of this quality tool in companies, since the crisis affected financial markets and various industrial sectors. (Dulci, 2009; Quevedo, 2009)

The articles were also analyzed for their application, or intended area (Figure 2), and as such, were divided into four groups:

I. Agribusiness: publications that used data for fields, crops or technologies used in rural areas;
II. Study: articles related to theoretical analysis, proofs, interpretations and use of the proposed control charts;
III. Industry: those that used data collected from industrial processes and case studies;
IV. Other: any scientific publication related to the subject that does not fit in the previous three areas.

**Figure 1**–Publications per Year



**Figure 2**–Publications per Area

Through this breakdown, one can see that agribusiness is developing in the area of univariate control charts in similar proportion to industry. On the other hand, multivariate charts are more prevalent in the area of study rather than sectors such as agribusiness or industry, which shows an area of development in this segment.

Within the selected period, the articles found were evaluated in relation to publication language. Despite the search for the keywords being done exclusively in Portuguese, they can also match the article abstract. Through this breakdown, it appears that the proportion of publications in Portuguese for univariate control charts is much higher than for other languages, which demonstrates a

consolidation of that theme in Brazil. On the other hand, multivariate control charts have similar proportions of publication in all three languages.

## 5. Conclusions

This article presents partial results of a bibliometric review of control charts in Brazil. The survey was conducted using the master database of national publications and some magazines chosen individually. The results show that this is an issue that can be further developed in the country, especially with regard to multivariate chart applications. As a suggestion for further research, additional analysis could be done on some qualitative aspects, such as citations. In addition, we intend to expand the research to cover the annals of scientific technical events in Brazil, and also international databases, in order to examine further the international coverage of national research on the topic.

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