

Quality impact, with the use of more than three sigmas in the statistical control of processes by variables

Afectación de la calidad, con el uso de más de tres sigmas en el control estadístico de procesos por variables

José Luis Hidalgo Torres*

ABSTRACT

The main objective of this study is to show how the use of more than $\pm 3\sigma$ in the formulas to determine the limits of the variables in the statistical process control charts affects the quality of the manufactured products and, consequently, the final consumer. In the research process, the induction and description methods were used to determine the required values of the parameters, constants and others used, which allow showing the proposed objective. The results in this study indicate that the use of more than $\pm 3\sigma$ in the statistical process control formulas by variables can have a negative impact on the quality of the final product. This is because the use of wider limits may allow more variability in the process to go undetected, which may result in more defective or out-of-specification products. Consequently, this can negatively affect customer satisfaction and company reputation. Therefore, it is important to take these findings into account when setting control limits on statistical process control charts.

Keywords: Show, limits, quality, methods, impact, variability.

RESUMEN

El objetivo principal de este estudio es mostrar cómo el uso de más de $\pm 3\sigma$ en las fórmulas para determinar los límites de las variables en las gráficas

* MsC Universidad César Vallejo, Lima, Perú. jlhidalgot@hotmail.com
<https://orcid.org/0000-0002-4671-3116>

JOURNAL OF BUSINESS
and entrepreneurial
studies

ISSN: 2576-0971



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Journal of Business and entrepreneurial
July - September Vol. 7 - 3 - 2023
<http://journalbusinesses.com/index.php/revista>
e-ISSN: 2576-0971
journalbusinessentrepreneurial@gmail.com
Receipt: 03 July 2022
Approval: 09 April 2023
Page 27-32

de control estadístico de procesos afecta la calidad de los productos fabricados y, en consecuencia, al consumidor final. En el proceso de investigación se utilizaron los métodos de inducción y de descripción, para ir determinando los valores requeridos de los parámetros, constantes y otros utilizados, que permiten mostrar el objetivo propuesto. Los resultados en este estudio indican que el uso de más de $\pm 3\sigma$ en las fórmulas de control estadístico de procesos por variables puede tener un impacto negativo en la calidad del producto final. Esto se debe a que el uso de límites más amplios puede permitir que más variabilidad en el proceso pase desapercibida, lo que puede resultar en una mayor cantidad de productos defectuosos o fuera de especificación. En consecuencia, esto puede afectar negativamente la satisfacción del cliente y la reputación de la empresa. Por lo tanto, es importante tener en cuenta estos hallazgos al establecer los límites de control en las gráficas de control estadístico de procesos.

Palabras clave: Mostrar, límites, calidad, métodos, impacto, variabilidad.

INTRODUCTION

Customer satisfaction and a company's reputation depend to a large extent on the quality of the products it offers. To ensure this quality, companies use a variety of tools and techniques, including statistical process control. This tool allows companies to monitor and improve the quality of their products through the use of statistical process control charts. However, the effectiveness of these charts depends largely on the choice of control limits. In this study, we examine how the use of more than $\pm 3\sigma$ in the formulas for determining the limits of variables in statistical process control charts affects the quality of the manufactured products and, consequently, the final consumer. Our findings indicate that the use of more than $\pm 3\sigma$ in statistical process control formulas by variables can have a negative impact on the quality of the final product. This is because the use of wider limits may allow more variability in the process to go undetected, which may result in more defective or out-of-specification products.

This can have a negative impact on customer satisfaction and company reputation. Therefore, our findings are important for companies seeking to improve the quality of their products through the use of statistical process control. This study provides valuable

information to help companies make informed decisions when setting control limits on statistical process control charts.

MATERIALS AND METHODS

Increments of sigmas, in the formulas for the calculation of the limits for the control charts by variables, the following research methods have been used: This method was used to go calculating, interpreting and concluding the results from the resolution of specific cases of examples proposed in several books of statistics that, in some of their topics, are related to the analysis of the statistical control of processes by variables.

Descriptive method: It was used to describe the processes and procedures applied to solve the problems and that allowed obtaining the results that will be shown later. Increments of sigmas, in the formulas for the calculation of the limits for the control charts by variables, the following research methods have been used:

Inductive method: This method was used to calculate, interpret and conclude the results from the resolution of specific cases of examples proposed in several statistics books that, in some of their topics, are related to the analysis of the statistical control of processes by variables. Descriptive method: It was used to describe the processes and procedures applied to solve the problems and that allowed obtaining the results that will be shown later.

RESULTS

Before starting to present the results obtained, it should be pointed out that the problems that were used were not solved according to the requirements requested in each one of them, but rather by applying the corresponding formulas for the calculation of parameters that are strictly related to the control charts by variables; that is, the data provided by them were used to be used for the aforementioned purposes of the research.

In order to show the results of the research, several stages have been established that will indicate the process and procedures applied:

MENTION OF THE PROBLEMS TO APPLY THE STATISTICAL CONTROL BY VARIABLES.

Taken from (Gutierrez_Pulido, 2009) It is desired that the strength of an article be at least 300 psi. To verify that such a quality characteristic is met, small periodic inspections are made and the data are recorded on an X - R chart. The subgroup size used is three items, which are taken consecutively every two hours. The data for the last 30 subgroups are shown below. Answer:

- a) Given that the mean of averages is 320.73, does the process meet the lower specification ($El = 300$)? Explain.
- b) Calculate the limits of the X - R chart and interpret them.

- c) Obtain the charts and interpret them (out points, trends, cycles, high variability, etc.).
- d) Give a preliminary estimate of the instability index, St. Louis.
- e) Does the process show a reasonable stability or state of statistical control?
- f) Make an analysis of the capacity of the process:
 - i) Estimate the standard deviation of the process.
 - ii) Calculate the real limits of the process and interpret them.
 - iii) Obtain a histogram for the individual data.
 - iv) Calculate the Cpi index and interpret it.
- v) Using Table 5.2 (Chapter 5), estimate the percentage of product that does not meet the lower specification.
- vi) Is the process capable of meeting specifications?
- g) If you proceeded properly, in the previous paragraph you will find that the process capability is bad, but how do you explain this if none of the data in table 7.5 is less than 310.0? Please argue your answer.
- h) To which aspect would you recommend focusing improvement efforts: capacity or stability? Argument.

Taken from (Kelmansky, 2009) Let us continue with volumetric capacity data (section 21.1.1.1.1.) for a process with mean 47 dm³ and standard deviation of 0.666 dm³. We use this time a control chart X, with n=5. That is, we average the volumetric capacity of 5 carafes every hour, for 16 hours.

Taken from (Ruiz & Rojas, 2006) The gauge of the sinkers is a key characteristic for their good performance. The following table shows measurements of 20 samples of size 5. Construct the control charts X - R, X - S and X - S*.

Taken from (Gutiérrez_Pulido, 2009) In the manufacture of optical discs a machine metallizes the disc. To ensure uniformity of the metal on the disc, the density should be 1.93, with a tolerance of ±0.12. Table 7.7 shows the data obtained for an initial study with subgroup size of 5.

- a) Calculate the control limits for the X-R charts and interpret them.
- b) Plot the X-R chart and interpret it.
- c) Does the process have an acceptable stability? Argument.
- d) Conduct a capacity study for this purpose:
 - i) Estimate the standard deviation of the process.
 - ii) Calculate the real limits of the process and interpret them.
 - iii) Obtain a histogram for the individual data, insert specifications and interpret in detail.
- iv) Calculate the capacity indexes and interpret them.
- v) Using Table 5.2 (Chapter 5), estimate the percentage of product that does not meet specifications.
- vi) Is the process capable of meeting specifications?

- e) On which aspect would you recommend focusing improvement efforts: capacity or stability?

The results of this study have important implications for companies seeking to improve the quality of their products through the use of statistical process control. Our findings indicate that the use of more than $\pm 3\sigma$ in the formulas for determining the limits of variables in statistical process control charts can have a negative impact on the quality of the final product. This is because the use of wider limits may allow more variability in the process to go undetected, which can result in more defective or out-of-specification products.

The findings have important implications for companies seeking to improve the quality of their products through the use of statistical process control. They suggest that it is important to take care in setting control limits on statistical process control charts and to consider the impact that the use of wider limits may have on final product quality. However, it is also important to keep in mind the limitations of this study and the need for future research to further explore these issues.

In summary, this study provides valuable information on how the use of more than $\pm 3\sigma$ in the formulas for determining the limits of variables in statistical process control charts can affect the quality of the final product. The findings suggest that it is important to take care when setting control limits and to consider the impact that the use of wider limits may have on final product quality.

Future research could further explore these issues and provide additional information to help companies make informed decisions on how to improve the quality of their products through the use of statistical process control by variables.

CONCLUSIONS

Only by assuming a $\pm 1\sigma$, it is possible to determine the existence of F.C.E. points, with more sigmas the existence of points that are F.C.E. is almost null; points that represent all the elements of each one of the samples, which can be that all or some of the elements of the sample are F.C.E., causing that the whole sample is F.C.E.

Effects of increasing sigmas in the use of control charts by variables:

By calculating the limits varying from $\pm 1\sigma$, ..., $\pm 6\sigma$, it is determined and visualized graphically that the values of the limits expand towards the lateral extremes in the manner of an arithmetic progression, with respect to $\pm 1\sigma$.

The expansion of the limits causes more elements to be accepted as valid.

Regarding the process capability C_p ; it has that with more $\pm 1\sigma$ and in the best of the cases with $\pm 2\sigma$ it is had that the processes are $\geq 1,33$; parameter averagely accepted worldwide with purposes that the results of the manufacturing processes, deliver quality products for the consumer. With $\geq \pm 2\sigma$ the process capability indexes show a total deficiency.

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