# Utilization of Statistical Process Control (SPC) for Monitoring Title in a Polyamide Yarn Spinning

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**Abstract:** The main objective of this study was to reduce the losses of polyamide bobbins due to spinning process variability. To assess this situation, the company's sampling plan was used, and the plotting was done using Minitab software. The study enabled the identification of title pumps with special cause standard deviation exceeding the plotted control limits. The analysis allowed the evaluation of process performance and capability. The study demonstrated that acting with the quality management tool on positions/spindles that showed high standard deviation reduced the number of bobbins with title below the control limit by 46,15%, generating a monetary gain for the company and highlighting the necessity of applying Statistical Process Control (SPC) in industrial processes
**Keywords:** statistical process control (SPC), capability, polyamide spinning, synthetic spinning.

## Utilização do Controle Estatístico de Processo (CEP) para Monitoramento do Título em uma Fiação de Fio de Poliamida

**Resumo:** Este estudo teve como objetivo principal a redução das perdas de bobinas de poliamida provenientes de variabilidade no processo de fiação. Para avaliar esta situação utilizou-se o plano de amostragem de uma empresa e a plotagem foi feita no software Minitab. O estudo possibilitou a identificação de bombas de título com desvio padrão por causas especiais, que extrapolavam os limites de controle plotados. A análise permitiu avaliar o desempenho e a capabilidade do processo. O estudo demonstrou que a atuação com a ferramenta de gestão de qualidade nas posições/fusos que apresentaram desvio padrão alto, reduziu em 46,15% o número de bobinas com título abaixo do limite de controle, gerando um ganho monetário para a empresa e evidenciando a necessidade da aplicação do Controle Estatístico de processo (CEP) em processos industriais.
**Palavras-chave:** Controle estatístico do processo (CEP), capabilidade, fiação de poliamida, fiação sintética.

## Uso De Control Estadístico De Procesos (Cep) Para El Monitoreo Del Título En Una Fábrica De Hilatura De Hilo De Poliamida

**Resumen:** El objetivo principal de este estudio fue reducir las pérdidas en bobinas de poliamida resultantes de la variabilidad en el proceso de hilado. Para evaluar esta situación se utilizó el plan de muestreo de una empresa y el trazado se realizó mediante el software Minitab. El estudio permitió identificar bombas de título con desviación estándar debido a causas especiales, que excedieron los límites de control graficados. El análisis permitió evaluar el desempeño y capacidad del proceso. El estudio demostró que el uso de la herramienta de gestión de calidad en posiciones/husillos que presentaron alta desviación estándar redujo en 46,15% el número de carretes con título por debajo del límite de control, generando una ganancia monetaria para la empresa y resaltando la necesidad de aplicar el Control Estadístico de Procesos (CEP) en los procesos industriales.
**Palabras clave:** control estadístico de procesos (CEP), capacidad, hilado de poliamida, hilado sintético.

## INTRODUCTION

The textile sector in Brazil has been facing several challenges to remain competitive in the market, influenced by both internal and external factors. This challenge extends to production and quality areas where competitiveness is evident. The synthetic spinning process in the textile sector is not immune to the chain reaction of this sector. Thus, quality management is emphasized to ensure that customer requirements are met, thereby ensuring competitiveness and market prominence.

In synthetic spinning companies, product title is controlled by title pumps or dosing pumps. Title is considered the most critical of possible yarn quality deviations, requiring the prevention of irregularities to avoid product rejection due to quality deviation and consequent loss of invested resources.

Quality management applied to production of goods has undergone modifications and adaptations over the years. The practice, initially carried out by the manufacturers and artisans themselves, gained prominence during the industrial revolution when it began to be audited by an external inspector responsible strictly for quality (ALVES, et al. 2022 e CALHEIROS, 2018).

Quality, in general terms, can be described as the degree of satisfaction of various characteristics to meet requirements (ISO 2015). In this context, capability analysis serves as a way to evaluate the process's ability to ensure product specifications and characteristics meet the designed tolerances with available resources (ALVES, et al. 2022 e CALHEIROS, 2018).

Variability measures the degree of dispersion of results, considering the mean value of samples. In companies, it is desirable that variability be as low as possible, ensuring uniformity of production. Variability causes can be common or

special. A common cause affects the process as a whole, forming a pattern within the sample group that can only be reduced by changes in process design. A special cause, on the other hand, affects specific points in the sampling, generating results that deviate from other sample values (NARCISO FILHO, 2016).

One way to represent sample dispersion is through control charts, which represent statistical measures of range, variance, or standard deviation. These

are statistical analyses, meaning they are performed with sampling, which help solve efficiency and effectiveness problems in large corporations (GUEVARA, et al. 2016).

The process of constructing a control chart basically involves defining upper and lower control limits, establishing a sampling plan, measuring the characteristic to be studied, and

plotting the charts. Afterward, one can verify if the process is under control and analyze if the process requires any action (6SIGMATOOL, 2025).

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Process capability can be evaluated using Cp and Cpk indices. Cp compares the permitted specification dispersion with process variation, with Cp>1 indicating that the process can meet the specification. Cpk evaluates the distance from the process mean to the allowed limits, with Cpk>1 indicating a capable process. Some companies adopt Cpk>1.33, a stricter index that demands more from the process. Process performance can be represented by Pp and Ppk, which are predictions independent of whether the process followed normality or not (NARCISO FILHO, 2016).

Based on these statistical tools, this work aims to determine and act on title pumps in polyamide spinning to increase process capability by reducing losses due to out-of-specification products.

## METHODOLOGY

This research is characterized as qualitative, focusing on understanding the factors that influence yarn count variability in a polyamide spinning unit. According to Flick (2018), the qualitative approach is appropriate for interpreting complex phenomena in specific contexts, being particularly effective in studies involving industrial processes and their operational variables.

The study was conducted in a continuous filament spinning plant located in the state of São Paulo, Brazil, which produces a variety of single and plied yarn counts. For the analysis, the 55/34 dTex yarn was selected, as it is the finest currently produced in the unit and, consequently, the one with the highest operational criticality—especially in the subsequent texturizing process, where yarn breaks are observed more frequently. Due to this sensitivity, the spinning machine responsible for this yarn count has been the target of investments and continuous improvement actions.

Data collection was based on a historical survey of the daily analysis of the 55/34 yarn count, using the routine operational sampling of the company's textile laboratory. The data are

manually recorded in spreadsheets and represent a composite sampling with multiple sources of variation—covering different time periods and 12 distinct winding positions. This structure allowed comparisons between positions, aiming to evaluate the current process performance (Ppk) and its variability.

For the statistical analysis, the tools "Process Capability SixPack" and "X-bar" from the Minitab software were employed, enabling graphical visualization and the calculation of capability and performance indices (MINITAB, 2023).

Initial results revealed that two specific spinning positions presented values below the lower control limit, characterizing occasional anomalies in the process. These variations were classified as special causes, since they affected only isolated positions and did not represent an overall shift in the process mean.

Based on this finding, a second analysis was carried out, excluding the positions with abnormal behavior. Each position of the spinning machine has a metering pump responsible for controlling the yarn count, and the excluded positions were flagged for mechanical inspection or replacement, in order to align their performance with the others.

In the final stage, the exclusion of the deviating positions allowed for a more accurate assessment of process capability, highlighting the need for technical interventions and operational adjustments to ensure greater stability. Thus, this study contributes to understanding the factors that compromise the consistency of the 55/34 dTex yarn spinning process, while proposing continuous improvement strategies aimed at product quality, reduction of production losses, and increased operational efficiency of the plant.

## RESULTS AND DISCUSSION

The collected data were plotted using Minitab software, with the result from the "Process Capability SixPack" illustrated in Figure 1, which includes X-bar S charts, capability histogram, normal probability plot, capability plot, and distribution of the last 12 subgroups.

The Figure 1 shows that the process had two points (spinning positions 6 and 7) outside the calculated lower control limit for the sample, characterizing an anomaly in the process. This anomaly is due to special cause, affecting only specific positions and not a total sample shift.
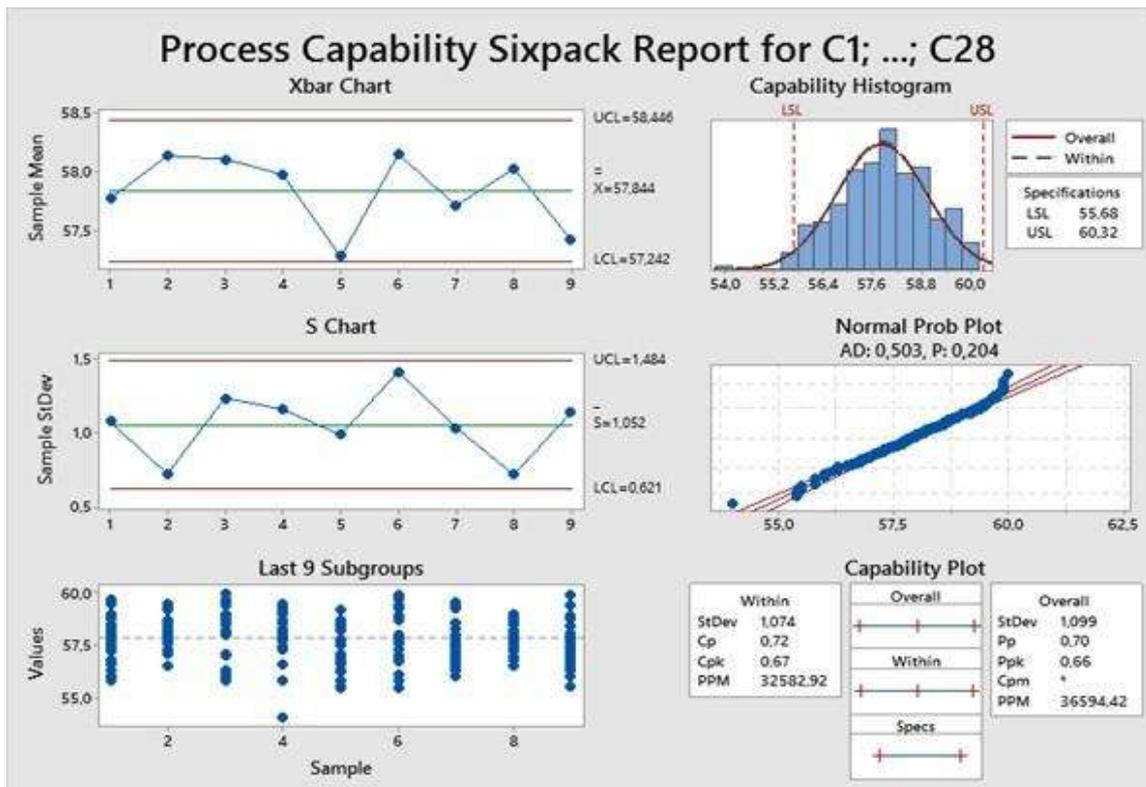
**Figure 1.** Plot with all collected samples.
**Source:** Prepared by the author using Minitab Software, 2025.

The values used to evaluate process performance were Pp and Ppk, both below 1 in Figure 1. The ideal for a well-performing process is equal to or greater than 1. The disparity between Pp and Cp and between Ppk and Cpk is justified by sample anomalies; thus, Cp and Cpk values are meaningless for this chart.

To evaluate process capability assuming normality, samples exceeding control limits were removed, each point being a spinning position. The spinning machine comprises twelve positions, each with a dosing pump responsible for title. The removed positions could undergo mechanical inspection or replacement of title pumps to align with the other positions' sample population. The new plot with only predictable, normal samples is shown in Figure 2.

**Figure 2.** Plot of Samples following normality
**Source:** Prepared by the author using Minitab Software, 2025.

In Figure 2, without the anomalous title pump data, Cp is closer to Pp, and Cpk is closer to Ppk, as expected since when samples follow normality, capability (Cp and Cpk) approaches process performance prediction (Pp and Ppk).

Even after the special cause study and removal of deviant positions, Cp and Cpk remained below 1, indicatîng common causes influencing overall process capability, warranting future study. Process performance improved from 6050373 defects per million (PPM) to 3659442. Considering process capability, defects per million reduced to 3258292. The gain related to process normalization is described in Table 1.

Table 1 – Analysis of gains with process normalization

| Variable | PPM | | Reduction | Average monthly production (Kg) | Monthly waste reduction (Kg) |
|---|---|---|---|---|---|
| | Before | After | | | |
| Deviated Coils | 60503,73 | 32582,92 | 46,15% | 82.130 | 2.293,14 |

Source: Prepared by the author, 2025.

As observed in Table 1, implementing solutions to normalize the process would financially benefit the company, with the feasibility evaluation suggested considering the costs involved in adjusting the identified title pumps.

## CONCLUSION

The analysis presented evidences the need for statistical process control and the benefits achievable with this type of analysis. This tool can and should be used in other textile processes to indicate capability and quality deviations analytically.

The results identified anomalies in specific spinning positions, enabling future actions at these points. Considering these actions, a new plot identified a significant reduction in defects per million generated in the process. This reduction equates to 4615% less waste, which for the current plant production translates to over two tons per month.

The analysis also indicated that even with the removal of anomalous points, the process-maintained Cp and Cpk below 1, statistically considered an incapable process. This result suggests common causes of process deviation, requiring process design changes to achieve a Cp and Cpk greater than 1.

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