ENGINEERING.
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QUALITY TOOLS AND PROCESS STANDARDIZATION: A CASE STUDY IN A TEXTILE COMPANY

FERRAMENTAS DA QUALIDADE E PADRONIZAÇÃO DE PROCESSOS UM ESTUDO DE CASO EM EMPRESA TÊXTIL

HERRAMIENTAS DE CALIDAD Y ESTANDARIZACIÓN DE PROCESOS: UN ESTUDIO DE CASO EN UNA EMPRESA TEXTIL

https://doi.org/10.56238/edimpacto2025.086-007

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ABSTRACT

The adoption of quality tools in conjunction with the PDCA cycle constitutes one of the foundations of continuous improvement in production processes. Although widely used, their practical application in traditional industries, such as textiles, still lacks more detailed analyses of their impacts and limitations. This article aims to investigate the effects of implementing quality tools and the PDCA cycle in the flat knitting sector of a textile company located in Santa Catarina, focusing on process standardization and reducing nonconformities. Methodologically, this is a descriptive case study, conducted through the integrated application of brainstorming, the GUT matrix, 5W1H, check sheets, and standardization via Standard Operating Procedures (SOP). The results demonstrated a significant reduction in dimensional nonconformities of produced parts, greater clarity in technical specifications, and standardization of operational routines. On the other hand, a decrease of approximately 30% in daily productivity was observed, demonstrating that quality improvements can generate trade-offs in terms of operational efficiency. As a contribution, the study reinforces the importance of systematically using quality tools in the textile sector, demonstrating their potential to increase reliability and reduce waste. It also highlights the need for future research on the balance between quality and productivity. Furthermore, it points to ways to integrate these tools with contemporary approaches, such as Lean Manufacturing and Industry 4.0, expanding their applicability in competitive and dynamic environments.

Keywords: Quality Tools. PDCA. Process Standardization. Textile Industry. Continuous Improvement.

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RESUMO
A adoção de ferramentas da qualidade em conjunto com o ciclo PDCA constitui um dos alicerces da melhoria contínua nos processos produtivos. Embora amplamente difundidas, sua aplicação prática em indústrias tradicionais, como a têxtil, ainda carece de análises mais detalhadas sobre impactos e limitações. Este artigo tem como objetivo investigar os efeitos da implantação das ferramentas da qualidade e do ciclo PDCA no setor de malharia retilínea de uma empresa têxtil localizada em Santa Catarina, com foco na padronização de processos e na redução de não conformidades. Metodologicamente, trata-se de um estudo de caso descritivo, conduzido por meio da aplicação integrada de brainstorming, matriz GUT, 5W1H, folhas de verificação e padronização via Procedimento Operacional Padrão (POP). Os resultados demonstraram significativa redução nas não conformidades de dimensões das peças produzidas, maior clareza na ficha técnica e padronização das rotinas operacionais. Por outro lado, observou-se queda de aproximadamente 30% na produtividade diária, evidenciando que a melhoria da qualidade pode gerar trade-offs em termos de eficiência operacional. Como contribuição, o estudo reforça a importância da utilização sistemática das ferramentas da qualidade no setor têxtil, demonstrando seu potencial para aumentar a confiabilidade e reduzir desperdícios, mas também sinaliza a necessidade de pesquisas futuras sobre o equilíbrio entre qualidade e produtividade. Além disso, aponta caminhos para a integração dessas ferramentas a abordagens contemporâneas, como Lean Manufacturing e Indústria 4.0, ampliando sua aplicabilidade em ambientes competitivos e dinâmicos.

Palavras-chave: Ferramentas da Qualidade. PDCA. Padronização de Processos. Indústria Têxtil. Melhoria Contínua.

RESUMEN
La adopción de herramientas de calidad, junto con el ciclo PDCA, constituye uno de los pilares de la mejora continua en los procesos productivos. Si bien su uso es generalizado, su aplicación práctica en industrias tradicionales, como la textil, aún carece de análisis más detallados de sus impactos y limitaciones. Este artículo tiene como objetivo investigar los efectos de la implementación de herramientas de calidad y el ciclo PDCA en el sector de géneros de punto planos de una empresa textil ubicada en Santa Catarina, centrándose en la estandarización de procesos y la reducción de no conformidades. Metodológicamente, se trata de un estudio de caso descriptivo, realizado mediante la aplicación integrada de lluvia de ideas, la matriz GUT, 5W1H, hojas de verificación y estandarización mediante Procedimientos Operativos Estándar (POE). Los resultados demostraron una reducción significativa de las no conformidades dimensionales de las piezas producidas, una mayor claridad en las especificaciones técnicas y la estandarización de las rutinas operativas. Por otro lado, se observó una disminución de aproximadamente el 30% en la productividad diaria, lo que demuestra que las mejoras de calidad pueden generar compensaciones en términos de eficiencia operativa. Como contribución, el estudio refuerza la importancia del uso sistemático de herramientas de calidad en el sector textil, demostrando su potencial para aumentar la fiabilidad y reducir el desperdicio. También destaca la necesidad de futuras investigaciones sobre el equilibrio entre calidad y productividad. Además, señala maneras de integrar estas herramientas con enfoques contemporáneos, como la Manufactura Esbelta y la Industria 4.0, ampliando su aplicabilidad en entornos competitivos y dinámicos.

Palabras clave: Herramientas de Calidad. PDCA. Estandarización de Procesos. Industria Textil. Mejora Continua.

1 INTRODUCTION

Dedication to quality has always been present throughout manufacturing processes, and has recently gained evidence for generating increased competitiveness in companies. The concepts of quality management and the tools for its continuous improvement have gradually developed over time, following the historical progress of manufacturing processes, reaching the point of being considered basic tools for organizations to have sustainability in the market (COSTA NETO; CANUTO, 2010).

The industrial environment is characterized by the importance of knowledge and technology, demanding the use of modern and efficient management techniques. Care for quality has intensified in recent years. Due to the increase in competitiveness, the application of quality management concepts and techniques show increasing convergence, since quality is no longer a differential, but a fundamental requirement in goods and services, which enables the improvement and effectiveness of management in a global environment (OLIVEIRA et al., 2009).

The realization of this article started from the need to identify which quality tools have the greatest impact on the reduction of errors and waste within the scope of a textile industry, thus seeking to improve its competitiveness in the market.

Thus, the main objective was to investigate through the case study the application of quality tools in a textile company, more specifically in the sector of production of rectilinear articles, operating in the state of Santa Catarina.

To this end, in addition to this brief introduction, item two presents a review of textile processes and quality tools, item three presents the research methodology, item four presents the results and discussions of the research and finally, item five presents the conclusions.

2 TEXTILE INDUSTRY PROCESSES AND QUALITY TOOLS

The production processes in the textile industries are characterized by a sequence of operations forming a chain in which the result of one stage is an input for the next stage. The products obtained by the rectilinear looms are examples of inputs produced by the company that will be used in the subsequent stages of the process, these inputs are most often collars, cuffs, waistbands and bars that give final finish to a piece.

The inputs obtained by the rectilinear looms should not go through a subsequent cutting stage, that is, the dimensions should be according to plan, any change can impact the process as a whole and in many cases, in addition to rework, it is not possible to use the input, therefore, it is necessary to develop a quality process to reduce waste. According to

Carvalho and Paladini (2005), Crosby defines quality as "Compliance with specifications", that is, compliance with the planned requirements.

Quality has to be developed, directly targeting its target audience. To do so, it is necessary to meet the consumer as to what he wants from the product or service and as to the price. For Wernke (2000), a quality product or service "is one that meets the needs and that is within its possibility of purchase, that is, it has a fair price". Campos (1992) also states that "a quality product or service is one that meets the customer's needs perfectly, reliably, affordably, safely and at the right time".

Based on the importance of the quality of the inputs obtained by the process, it is relevant to work with quality tools that are capable of optimizing the process as a whole, reducing waste and rework, making the final product meet customer expectations, especially in relation to design and fair price.

As the focus of the research is specifically on the process of weaving a straight mesh, this review will emphasize this process. In this case, in the weaving process on rectilinear looms it is possible to weave numerous models and colors of pieces in rectilinear, it all depends on the development and engineering sector. For the development of rectilinear threads there are three main types of threads, which result in products with different characteristics and aspects, which are dyed threads, raw threads and threads with a mixed effect.

The raw yarns are made of 100% cotton and usually after the weaving process it goes to the dyeing process, where the raw fiber acquires the planned color. Dyed threads are 100% polyester composition threads purchased in the desired final color and these are used most of the time to compose the stripes or details in the rectilinear. Blended yarns are composed of the union of two fibers of different compositions, which makes the material acquire the expected appearance and color (blend). The following figure shows a product with rectilinear applications that are the collars and cuffs of the t-shirts. In Figure 1, the collar is made of blended yarn and dyed to acquire the blue color.

Figure 1

Example of a product made on a straight loom (collar)

Source: The authors.

2.1 QUALITY CONCEPTS AND TOOLS

In this article, the PDCA cycle will be applied and throughout its unfolding some quality tools will be used. The PDCA Cycle, also known as the Quality Cycle or Deming Cycle, so called because it was developed by Edwards Deming in the 50s, is a methodology that has as its basic function the aid in the diagnosis, analysis and prognosis of organizational problems, being extremely useful for problem solving. It is an instrument used for the search for improvement in this method of continuous improvement (QUINQUIOLO, 2002).

As the use of the PDCA Cycle is closely linked to the understanding of the concept of process, it is important that all those involved in its application understand the procedural vision as the clear identification of inputs, customers and the outputs they acquire, in addition to the internal relationships that exist in the organization (TACHIZAWA; SACAICO, 1997). As can be seen in the nomenclature itself, the PDCA Cycle is divided into four well-defined and distinct phases, as detailed in Figure 2.

Figure 2

PDCA Cycle

Source: Bezerra (2014).

The four phases of the cycle according to Bezerra (2014) are: the phase (PLAN) consists of planning and establishing a plan based on the company's guidelines, stipulating the objectives, paths and methods to be followed. In this phase, the problems are identified

and an action plan is planned to correct them; the phase (DO) means to do, that is, to put the planning into practice, this phase aims to execute the action plan prepared in the planning stage. In this case, the conduction of the plan, the observations made and the collection of data; In the phase (CHECK), it is necessary to evaluate what was done during the first two stages, comparing and identifying the differences between what was planned and what was accomplished. What was learned during the execution of the plan should be verified, verifying whether the objectives were achieved or not; and finally the phase (ACTION) is the part where the corrective actions of the plan are applied, correcting the flaws found during the process. After correction, the cycle must be repeated, continuing the process of continuous improvement.

Throughout the application of the phases of the PDCA cycle, the various quality tools are used, such as: Brainstorming, GUT Matrix, 5W2H, among other tools that allow the analysis, development and application of improvement actions in the processes.

Brainstorming is a method created in the United States by publicist Alex Osborn. It is a group or individual technique in which mental exercises are carried out in order to solve specific problems, to develop new ideas or projects, to gather information and to stimulate creative thinking (BEM, 2023).

First, the ideas are generated, then these ideas must be directed to the realization of clarifications related to the process and finally the evaluation of the proposed ideas. The most important thing about brainstorming is what happens after the meeting. According to him, no matter how simple the session was, good ideas will always emerge, however, depending on what happens after the meetings, the ideas may or may not generate satisfactory results (BEM, 2023).

The GUT Matrix is widely used by companies in order to prioritize problems and consequently treat them, taking into account their severity, urgency and trends (BASTOS, 2014). Also according to Bastos 2014, it is necessary to separate each problem and after that to know the priority in solving the identified problems, the GUT Matrix acts precisely in this aspect, selecting and escalating the problems, taking into account the positive and negative impacts that their correction can bring. To evaluate the parameters of severity, urgency and trend, the characteristics of each score were used as a basis, 1 without severity and 5 extremely severe, which can be seen in Figure 3.

Figure 3

GUT Matrix Notes

Nota	Gravidade	Urgência	Tendência ("se nada for feito...")
5	extremamente grave	precisa de ação imediata	...irá piorar rapidamente
4	muito grave	é urgente	...irá piorar em pouco tempo
3	grave	o mais rápido possível	...irá piorar
2	pouco grave	pouco urgente	...irá piorar a longo prazo
1	sem gravidade	pode esperar	...não irá mudar

Source: Bastos (2014).

The 5W2H methodology, consisting of seven questions, according to Oliveira (1996), such as: what? Identifying what the subject is about; Who (who)? Assigning responsibilities to the people involved; where? Specifying the location of the activity; Why? Presenting why the operation is necessary; when? Stipulating deadlines to achieve results; how? Describing how the operation should be conducted; How much? Cost/benefit ratio of the operation. Figure 4 presents a summary of the 5W2H tool.

Figure 4

5W2H Tool

		Método 5W2H	
5W	What	O que?	Que a ação será executada?
	Who	Quem?	Quem irá executar/participar da ação
	Where	Onde?	Onde será executada a ação
	When	Quando?	Quando a ação será executada?
	Why	Porquê?	Por que a ação será executada?
2H	How	Como?	Como será executada a ação?
	How much	Quanto custa?	Quanto custa para executar a ação?

Source: SEBRAE (2023).

3 RESEARCH METHODOLOGY

This article is characterized by being descriptive, as this method systematically describes a certain area of interest. The technique used was a case study, that is, it aims at a deep and exhaustive analysis of one or a few issues, in order to allow a broad and detailed knowledge.

The study was carried out in a textile company, located in the city of Pomerode, in the state of Santa Catarina. Focusing on improving the rectilinear production process. The sector where the improvements were made is the knitting sector, specifically in the processes and products obtained by the rectilinear looms, the need for improvement in this sector was identified by the process leaders who were constantly looking for alternatives to improve the quality and minimize waste in the sector.

The stages of the development of the research followed the unfolding of the phases of the PDCA cycle, in this way, it can be stated that the stages of the research were divided into planning, execution, verification and standardization, as presented in item 2.1. which deals with the phases of the PDCA cycle.

4 RESULTS AND DISCUSSIONS

Starting from the principle of the PDCA cycle, for the realization of the planning and with the objective of identifying the critical points of the process, thus determining its objectives, brainstorming was carried out among the main members involved in the project, in this case, the leader of the rectilinear sector, a process analyst from the engineering sector, a member of the continuous improvement sector and the intern from the sector. The first meeting aimed to discuss the quality problems found in the sector for the application of the improvement project. Among the problems discussed, the sector leader pointed out that the biggest problem is the difficulty in ensuring that the input of the rectilinear process was in the dimension standards established by engineering, that is, many times an input was planned with specific dimensions and at the end of the process, in the verification stage, its width and length were larger or shorter than expected, and the programming made for production was standard. Other process problems were discussed, such as stock that sometimes does not correspond to the one registered in the system, needle breakage, yarn breakage, lack of experience and constant change of employees, difficulty in interpreting the engineering technical sheet, divergences in the registration between the engineering technical file and the system.

After brainstorming, the GUT Matrix was used to evaluate the problems and analyze the severity. To determine which problems should be prioritized, it was necessary to assess the severity, urgency and trend of each problem and multiply the factors. The scores for the problems found were decided by the group and according to the data obtained by the GUT Matrix, the problems that need to be prioritized are: i) non-conformity of sizes, total of 125 points; ii) training of operators, a total of 48 points; iii) improvement of information in the technical sheet, total of 36 points; iv) improvement of information in the system, a total of 36 points. The complete GUT matrix can be seen in Table 1.

Table 1

GUT Matrix

	Variável	G	U	T	TOTAL
		Gravidade	Urgência	Tendência	
1	Não-conformidade de tamanhos	5	5	5	125
2	Manchas de óleo	2	3	1	6
3	Treinamento dos operadores	3	4	4	48
4	Quebra de agulhas	2	2	2	8
5	Rompimento de fios	2	2	2	8
6	Melhoria no estoque	3	3	3	27
7	Melhoria de informações da FT	3	3	4	36
8	Melhoria de informações do sistema	4	3	3	36

Source: Prepared by the author.

With the results obtained by the GUT Matrix, the group decided to create an Action Plan to define the tasks to be performed. The proposals were presented following the 5W2H methodology, however, in relation to the indicator "How much?" which indicates the cost/benefit ratio of the operation, it was decided not to carry out the analysis, as most of the suggestions for improvements do not present significant costs, so the tool used is now called 5W1H. The Action Plan developed for the project with the help of the 5W1H tool can be seen in Table 2.

Table 2

Action Plan - 5W1H

O que?	Quem?	Onde?	Por que?	Quando?	Como?
Levantar os dados do setor de qualidade	Estagiária; Setor de qualidade	Dados do setor de qualidade	Para verificar por meio de dados quantificativos a os principais apontamentos de não-conformidades	1 de setembro	Entrando em contato com o coordenador de qualidade e via base de dados do MRP.
Verificar variáveis do processo	Equipe do projeto	Programa Excel	Para identificar as variáveis envolvidas no processo que podem estar influênciando nos resultados	28 de agosto à 1 de setembro	Observando o processo, identificando as influências para o determinado problema (inconformidade de tamanhos), classificar de acordo com diagrama de Ishikawa.
Criar/Aplicar/Analisar Folha de verificação	Analista de processos; Técnico da máquina; Estagiária	Setor de retilínea; Programa Excel	Para registrar os testes e avaliar os resultados obtidos, com o objetivo de identificar a causa raiz do problema.	6 de agosto à 6 de outubro	Com os dados obtidos pelo Diagrama de Ishikawa e da qualidade, criando uma planilha que segue as recomendações para elaboração de Werkema (2006). Fazer testes e verificar os parâmetros que mais influênciam no processo.
Apresentar os resultados da folha de verificação	Analista de processos	Sala de reuniões	Para apresentar os resultados e as alterações que devem ser realizadas	9 de outubro	Apresentar para os gerentes e lideres dos processos envolvidos as mudanças que devem ocorrer para melhorar os resultados.
Criar POP para o processo	Analista de processos; Estagiária	Setor de retilínea	Para padronizar o processo e para os operadores consultar sempre que houver dúvidas	10 à 13 de outubro	Analisar o processo e verificar a melhor maneira de realiza-lo. Anotar o passo a passo de cada operação de forma com que todos compreendam o processo.
Criar Check List para iniciar o processo	Analista de processos; Estagiária	Programa Excel	Para padronizar o início do processo e evitar problemas no decorrer do tecimento	10 à 13 de outubro	Verificando o processo e os passos necessários para iniciar a operação, registrando passo a passo.
Melhorar informações da ficha técnica	Estagiária; Analista de Engenharia	Programa Excel	Para agilizar o preenchimento de informações e facilitar o entendimento dos utilitários	16 à 20 de outubro	Eliminando as informações menos relevantes, alterando o layout da FT, adaptando fórmulas de preenchimento automático.
Melhorar informações do sistema	TI; Líder do setor	Programa Excel	Para facilitar o entendimento dos utilitários e melhorar a leitura de informações	16 à 20 de outubro	Melhorando a visualização da retilínea, adicionando o desenho e as medidas na OP.
Reunião e treinamento com os operadores	Analista de processos; Líder do setor	Sala de reuniões; Setor de retilínea	Mostrar as alterações que devem ser realizadas e os novos procedimentos	23 à 27 de outubro	Apresentar aos operadores de máquinas as medidas tomadas e instrui-los sobre as alterações, acompanhando o processo no setor.
Verificar os resultados	Estagiária	Dados do setor de qualidade	Verificar os resultados obtidos	10 de novembro	Analise dos registros de qualidade, quantificando os resultados obtidos com o projeto.

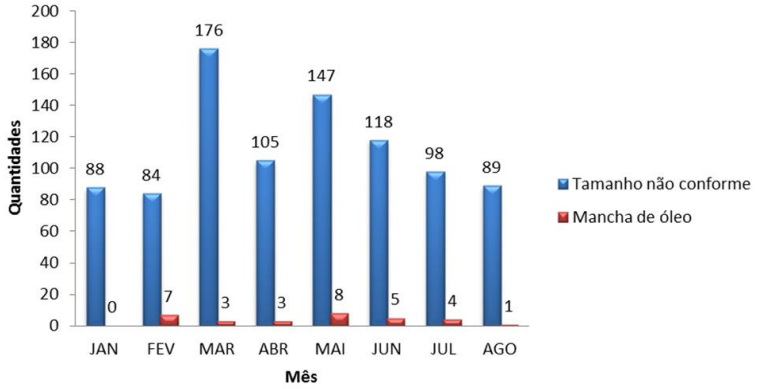
Source: Prepared by the author.

The second phase of the PDCA cycle is the phase where it must be done, that is, execute the action plan prepared in the first phase. The first action taken, according to the first task of the action plan, was to contact the company's quality sector in order to collect data on non-conformities in the rectilinear sector. The records obtained pointed out only two types of non-conformities obtained in the final result of the knitting phase, which are: non-conformity of sizes and oil stains on the pieces.

Figure 5 shows the quantities and types of defects found by the quality in the rectilinear knitting sector.

Figure 5

Graph of the main non-conformities in the rectilinear sector



Source: prepared by the author.

In view of the expressive values in relation to non-conformity related to size difference, the group focused on this improvement. During four weeks of work, numerous tests were carried out to define new standards and make improvements in the process. With the data obtained, it was possible to verify that the variables that most affect the result, that is, the type/brand of the machine used and type of yarn, its composition and consequently its characteristics, directly impact the final result of the process.

Analyzing the data, it was determined that the measurements registered in the machine programming would not be according to the technical sheet, because the technical sheet does not consider the shrinkage by type of yarn and the information of the machine that will be woven the rectilinear is only obtained after the programming of the PCP, that is, well after the planning and development of the technical sheet. The measurements for programming the machine must consider the height and width of the straight, the type of wire used and the machine that will do the process. As an immediate measure, it was determined that in each machine there should be a table with the measurements per stitch of each type of wire and the programmer would be responsible for checking the number of stitches according to the measurements of the straightener. This definition was presented to the coordinators and managers and approved as a corrective measure to improve the process.

To standardize the process and better understand the operators, the Standard Operating Procedure (SOP) was created. This tool is of great importance within the company, the basic objective is to ensure, through standardization, the expected results for each task performed, that is, it is a standardized script to carry out an activity.

The SOP created for the process presents instructions for checking materials, inserting the weaving program on the loom, inserting the number of needles to weave the graduation of the thread stitch and method for checking needles and columns, checking the rectilinear

measurements. It was established that the conference should be done every 30 minutes to ensure that the entire batch had the established measurements.

The rectilinear technical sheet filled out by the engineering sector that was used to register information in the system and consult machine operators was also restructured. In order for the information to be leaner and clearer for the operators and technicians, in this case, it was necessary to remove fields and information that were not used, so the form that was previously two pages went to only one.

In addition to the improvement in the layout and elimination of unnecessary information, the form was adapted in an Excel spreadsheet with formulas that, according to the measurement of the rectilinear and the stripes, already presents the proportion that must be registered of each color for the consumption of yarn and number of passes.

5 FINAL CONSIDERATIONS

In the survey, the main operations that needed improvement in the rectilinear production sector were identified. Quality tools such as brainstorming, GUT matrix and 5W1H proved to be effective in helping to define priorities and improvement actions. The priorities defined and executed with the help of the tools were: size non-conformities, improvement in the technical data sheet and system information and training of operators.

After surveying the improvement activities that should be done urgently, a verification sheet was created to monitor and record tests carried out on all types of machines and different types of wires used in the rectilinear, analyzing in addition to these variables the rest time of the batch and comparing the variation of measurements recorded. It was found that the type of machine and the type of wire were causing variation in sizes, it was taken as an immediate measure to improve the process, that the operator programmed the rectilinear according to the created table of density per machine and type of wire placed in each machine.

The quality tools proved to be efficient, facilitating the collection of information. Throughout the research, the sector's production process was monitored. Tests were carried out on samples, production monitoring and training and assistance to operators in order to establish a method that would improve the quality of the rectilinears, reducing the quality defects found. As a result of the work, an effective improvement in quality can be verified, but there was a reduction in the amount produced daily, around 30%.

In view of this, as a suggestion for future research, it is proposed to carry out new studies related to the improvement in productivity, improvement and assertiveness in the

stock of lines and adaptation of the new method of machine programming in the company's system, reducing operational activity and ensuring correct programming.

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