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Application de Kanban, Classification ABC, 5S, and Demand Forecasting to Reduced Order Non-Fulfillment in a Peruvian Textile SME

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Abstract

The objective of the study is to reduce the high-order non-fulfillment rate, which represents 60% and generates significant revenue losses. A management model is proposed integrating Kanban, ABC Classification, 5S, and triple exponential smoothing Demand Forecasting. Kanban optimizes workflow with a 2-minute cycle reduction, improving efficiency. ABC Classification prioritizes orders with a 30% increase in accuracy, allocating resources effectively. 5S promotes an organized and clean environment, reducing errors and improving operational efficiency. The Demand Forecast helped anticipate future needs, facilitating production planning and maintenance of an adequate stock of 42 units. These tools, applied after quantitative and qualitative research, address planning failures, warehouse disorder, inefficient workflow, and poor inventory control, with the potential to significantly reduce order non-compliance in a Peruvian SME Textile.

Keywords

Textile Industry, ABC classification,5S,Kanban,non-fulfillment of orders

Introduction

The textile sector is the most important sector within the manufacturing industry, covering different activities such as: the treatment of textile fibers for the production of yarn, and the manufacturing of clothing (Ministry of Production, 2020). According to Comex Perú (2021), this sector represents 0.8% of the Gross Domestic Product (GDP). However, in Peru there was a global crisis triggered by COVID-19 in 2020, which had a significant impact on the Peruvian textile sector, with a drop in exports of 42.85%. The most affected subsectors were: yarns with a reduction of 49.15%, followed by fabrics with a drop of 37.36%, and clothing with a drop of 40.93%. This event caused productivity and efficiency problems in the sector (CCL 2020). One of the main problems that most textile SMEs have is that management is unprofessional and informal. This lack of knowledge in the use of management tools leads to a high rate of order non-compliance. As a result, companies experience large losses in profitability and sustained growth (Larios Francia 2017). For this investigation, a Mype in the textile sector was taken into consideration, which has the main problem of 60% non-compliance with orders. The total cost per unfulfilled order is S/. 2852.66. On the other hand, the research is carried out by the methodologies: 5S, Kanban, Triple Smoothing Demand Forecasting, and ABC with the purpose of reducing order non-compliance and improving the workflow in the Mype. The application of said tools mentioned above is the result of a review of articles that contain the same problem and the execution of different tools. Order delivery is an important and decisive component for different companies, as it directly influences the reliability perceived by customers. Finally, said proposal was implemented and an investment was made for the proposed model of S/9000 soles the project is profitable because the IRR (81.35%) is greater than the COK (11.50%). Furthermore, it has a net present value (NPV) of 19,858 Pen and is positive. This indicates that the proposed model is

beneficial for the case study is good for the case study. This research is structured as follows: introduction, objectives, literature review, methods, validation, results, discussion, and conclusion.

1.1 Objectives

The main objective of the research is to propose a management model to reduce order non-compliance through the application of Kanban, ABC Classification, 5S, Demand Forecasting tools in a textile SME. In addition, the following specific objectives were proposed: prepare the background and state of the art of the project, carry out the analysis and diagnosis of the problem using industrial engineering tools, design and develop solution proposals, and validate the solution.

2. Literature Review

2.1 5s

The 5S method is a Lean Manufacturing method used to optimize productivity and reduce waste in processes and maintain an orderly workplace (Tkhorikov and Zakharov 2019). Furthermore, the name 5S originates from five Japanese words that begin with the letter "S". These words are: seiri, seiton, seiso, seiketsu, shitsuke. (Cardoso et al. 2018).

2.2 Kanban

Kanban is a visualization system that is used in production processes. It coordinates the timely delivery of each component in an assembly line at the necessary time, avoiding overproduction and unnecessary storage (Gaete et al. 2021). This method uses cards that show the starting point of a task and include information such as ID, name, estimated time, and the person assigned to the task. Each card has a status pending, in progress, completed and is shared by the entire work team, helping to minimize work in process or stock in process. (Darío et al. 2014)

2.3 ABC

ABC classification is a tool with the objective of positioning high-moving materials in the main racks to see enough of them through the 80/20 Pareto rule. (Macías Acosta et al. 2019) Products classified as type A are the most important for the organization since they represent the highest-value items. These represent between 60% and 80% of the total inventory value. Type B products are of secondary importance, representing between 15% and 25% of the inventory value. Finally, type C products are the least important, being able to represent around 50% of the references, but only 5% or less of the inventory value (Parada Gutiérrez, n.d.)

2.4 Demand forecasting Triple exponential smoothing

The triple exponential smoothing demand forecasting model is an effective tool as it forecasts future demand and optimizes inventory costs. In this method, it is capable of handling univariate time series that include both trends and seasonality (Jamis Mejía Vásquez & Gonzales Chávez 2019).

3. Methods

3.1 Basico

The proposed model is based on Lean and inventory techniques where the development has been effective in a company in the textile sector, highlighting for this work the techniques of ABC Classification, 5S, Kanban and Demand Forecasting, to reduce order non-compliance in a company. mype textile company, it should be noted that everything must be quantified by KPIs to validate the proposed improvement, which is why we use a detailed comparison matrix in Table 1.

Table 1. Comparative Matrix

Components / Scientific articles	Organization elements	Product Categorization	Production Optimization	Adjusting for fluctuating demand fluctuations
(M. et al., 2019)		ABC,Just Time		
(Srinivasa Rao et al., 2022)		ABC		
(Ren et al., 2020)				Demand Forecast
(E. & ., 2021)				Box-Jensis Methodology Demand Forecast
(Cardoso et al., 2018)	5S, Kaizen			
(Carrera et al., 2021)	5S,7S			
(Do Nascimento et al., 2024)			Lean Six Sigman Kanban	
(Montalvo-Soto et al., 2020)			SLP,Kanban	
Proposal	5S	ABC	Kanban	Demand Forecast

3.2 Proposed model

The proposed model is based on Kanban, 5S, ABC classification, and demand forecasting tools with the main objective of reducing order delivery.

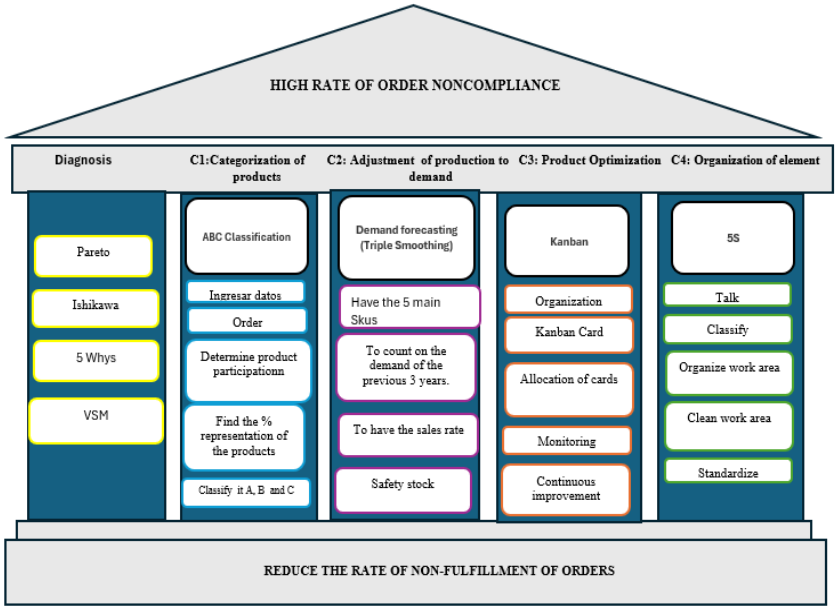

Figure1.Proposed Model

A diagnosis was carried out to detect the underlying problem in order to solve the non-fulfillment of orders. Subsequently, a Pareto Diagram was developed to evaluate the relevance of the different reasons and causes. In addition, the 5 whys and the Ishikawa diagram were made to visualize all the possible causes.

3.3 Components

3.3.1. Component 1: Categorization of products according to their degree of importance.

According to (Alcalde et al. 2023), in order to generate added value, the analysis of the warehouse stock was carried out together with the simulation and implementation of ABC to sort the items in this area and avoid changes in the process. Therefore, for the case study, the ABC classification was developed, which followed a series of planned steps with the objective of classifying the products according to their relevance within the company. Likewise, the products with the highest turnover and value were identified.

3.3.2. Component 2: Adjustment of production to demand

According to the author, "FashionTrend" store used the Triple Smoothing Demand Forecasting for type A clothing in the next period based on historical sales data, in which, they have collected sales data of type A clothing for the past 12 months (Sihotang 2023). For the case study, a demand projection tool was proposed based on the last 3 years of sales in order to plan production, and have the safety stock and sales rate. It was also classified by the 5 main SKUS.

3.3.3 Component 3: Product optimization

In a Colombian mype they used the Production Kanban, which helped production scheduling based on the target market: They meet the real demand and anticipate changes in both product design and processes (Riveros & Ballesteros, 2008). (Riveros & Ballesteros 2008) For the case study, it is proposed to use Kanban to optimize production management and increase efficiency concerning the number of orders to be placed.

3.3.4. Component 4: Organization of elements

To have a 5s program to establish order, classification, standardization, and cleanliness, among others. To improve the organizational culture (Piñero et al.2018). The third component is the use of the 5S tool to optimize both the organization and cleanliness of the textile company's work area to increase efficiency, productivity, and occupational safety positively. With the implementation of 5S in the company, a culture of continuous improvement will be fostered.

3.4 Indicators

The indicators that we will use for this investigation are the following: cycle time, production, fill rate, safety stock. Fill Rate: The aim is to have good service with orders in which there is an initial failure rate of orders of 60% and the aim is to increase it to 90%. Cycle time: This indicator evaluates the time it takes to deliver the order. We want to reduce order delivery by 15%. Safety Stock: It must be adequate because it meets customer orders and adjusts to changing market conditions. The objective is to reach a stock of 60 orders. Production: helps identify which areas should be improved and implement strategies to increase productivity. The goal is to produce 3000 sweaters for type A, for type B to decrease to 1000 sweaters, and for type C to 400 sweaters. Next, Table 2 shows the formulas to use for each indicator.

Table 2. Indicator

Indicator	Formula
Cycle Time	$\text{Cycle Time} = \frac{Sum\ of\ time\ performed}{Number\ of\ cycles\ performed}$
Production	$Production = Sales + Final\ Inventory\ of\ finished\ products\text{-}Initial\ Inventory\ of\ finished\ products$
Fill Rate	$\text{Fill Rate} = \frac{Number\ of\ completed\ orders}{Total\ orders}$
Safety Stock	$\text{Safety Stock} = \sqrt{Delivery\ time * standard\ deviation * Z}$

4. Data Collection

To narrow down the search results, certain keywords were selected, such as ABC classification, 5S, Demand Forecasting, and Kanban. The databases consulted for the research were: Scopus, Web of Science, Redalyc and ProQuest. The following combinations were also used: "abc" or "kanban" and "textile for order fulfillment" "5s" or "kanban" and "textile for order fulfillment", "5s" or "kanban" and "inventory management textile ","planning" and "forecasting" and "order delay" and "5s" or "kanban" or "abc"Using the above keyword combinations, 298707 articles were identified through the search The four selected databases were discarded articles that were not open access by document type, publication year from 2018 to 2023 and source type, resulting in a total of 300 articles. The titles and abstracts were subsequently reviewed, discarding a total. of 70 articles that did not meet the established criteria, leaving 230 articles, of which 182 articles were discarded because they did not belong to an indexed journal and did not have an adequate quartile, leaving 48 articles finally found according to the typologies

5. Results and Discussion

5.1 Numerical Results

A traffic light table has been created that presents the results obtained by using tools such as 5S, Kanban, ABC Classification and Demand Forecasting. The current results column shows the initial data collected at the beginning of the investigation, reflecting an order violation problem. The "Target" column indicates the values that were expected to be achieved. Finally, the "Improvement" column shows the results validated by Minitab. In this last column, the yellow color indicates that the objective has not been achieved, although an improvement in the indicators has been achieved. On the other hand, the green color indicates that the proposed objective has been exceeded.

Table 3. Model results

MODEL RESULTS							
Problem	**Current**	**Objective**	**Improved**	**Indicator**	**Current**	**Objective**	**Improved**
Non-fulfilment of orders	**60%**	**90%**	**30%**	Type A Production (amount)	**1901**	**3000**	**7849**
				Type B Production (amount)	**2331**	**1000**	**1156**
				Type C Production (amount)	**2649**	**400**	**205**
				Cycle time(minutes)	**7.02**	**6**	**5.76**
				Security Stock	**600**	**60**	**42**
				Product demand (units)	**3455**	**4000**	**3643**

5.2 Graphical Results

It is observed that the production of type A of 1901 units improved to 7849 units. For production B 2231 it was reduced to 1156 sweaters, a decrease in product type B is seen. While the production for type C was reduced by 92.2% Regarding cycle time, it improved by 19.74%. Its safety stock of 600 improved by 93%.

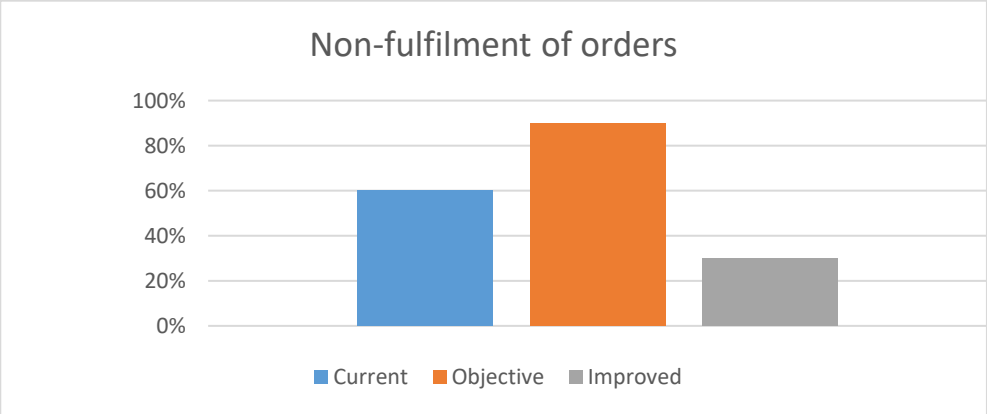

Figure 2. Non-Fulfillment of orders

5.3 Proposed Improvements

To successfully achieve the improvement proposal, a pilot test was carried out. In which it was necessary to carry out an initial audit and verification sheets so that its monitoring could be continued and established. Therefore, everything was carried out in a textile Mype in the warehouse area.

5.3 1. Application of ABC

The summary table shows us that the number of elements in Zone A was 9 elements, Zone B has a total of 8 elements. While in Zone C it has 19 elements. The percentage of accumulated investment in Zone A represents 79.80%, Zone B 14.43% and Zone C 5.77%.

Table 4. Application of ABC

Zone	N elements	% Articles	% Accumulated	% Investment	% Accumulated Inventory
A	9	25%	25%	79.80%	79.80%
B	8	22%	47%	14.43%	94.23%
C	19	53%	100%	5.77%	100.00%
Total	36				

5.3.2 Triple Smoothing Demand Forecasting Application

The forecast was made based on the 5 Skus indicated by ABC. They are the following:Back barrette, braided wool, rhombus glitter, pita glitter, duck glitter. We also take as reference the years 2021, 2022, 2021, 2022, 2023 and 2024 until the month of June. The triple exponential smoothing demand forecast was used since these present trend, level and seasonality. Furthermore, it was found that the coefficient of variation of the 5 forecasts was less than 50%. This indicates that there is little variability, that is, that it is a reliable forecast.

Table 5. Application Forecast

	Back Pinck	Wool Braid	Shiny Rhombus	Bright Pita	Glow Duck
Average	6.249	9.099	984	172	1.401
Deviation	334.334	640.946	75.675	13890	748.885
Sales rate	0.054	0.070	0.077	0.081	0.535
	6451	9178.33	1010.33	168.00	1212.67
Security stock	45.43	21.68	44.36	36.22	43.17
Service level	95%				
Z	1.65				
Standard deviation	19.47	9.29	19.01	15.52	18.50
Delivery time	2 days				
Production	6497	9201	1055	205	1256

5.3.3 Implementation of 5S

Below are the initial 5s scores. Therefore, a target of 10 in each. Table 5 will show the points and goals of each "5s". There are 27 points and 50 goals in total.

Table 6. 5s Initial Audit

ID	5S	Points	Goals
S1 (Seiri)	Select	7	10
S2 (Seiton)	Order	5	10
S3 (Seiso)	Clean	6	10
S4 (Seiketsu)	Standardization	5	10
S5 (Shitsuke)	Discipline	4	10
		27	**50**

1S: Seiri There are classification criteria such as unnecessary, recoverable, obsolete and in custody elements. Therefore, 2 items will be transferred, 8 will be deleted, 2 will be deleted, and 2 will be deleted, transferred and 14 will be repaired. Therefore, it is proposed to use red cards. In which, they will help identify which are the essential tools for the area.

2S: Seiton The organization of products A, B and C on the shelves will be taken into account, depending on the stock rotation of products A, B and C.

Table 7. Frecuencia del Material

Material Frequency	Frequency of use and location
Product A	Every hour with the person
Product B	Several times a week
Product C	Several times a day

3S: Seiso The objective is to have a more effective cleaning system in the company. Therefore, the company's cleaning flow diagram is shown below.

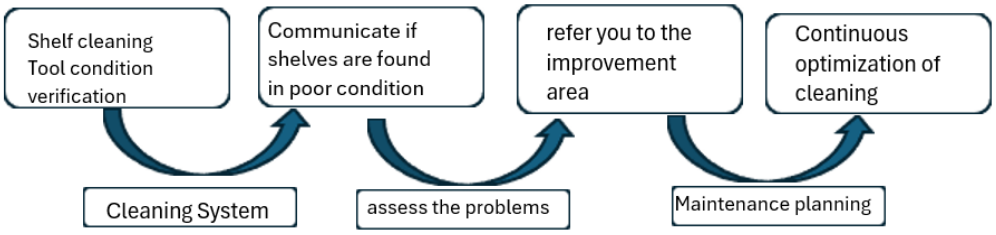

Figure 3. Seiso

4S Seiketsu In this phase, the objective is to verify that the achievements achieved in the three s (Seiri, Seiton and Seiso) through the protocols have optimal results.

Table 8. Verification sheet

5s and Kanban compliance checklist										
Inspection data			Finishing area				Warehouse			
Date	shift	supervisory	1°	2°	1°	2°	1°	2°	1°	2°
Criteria for review										
Identified and deleted items unnecessary work areas										
Verification of classification and										
Recording of daily production										
Work areas are clean and tidy										
Operators and supervisors comply with what they have Implemented to prevent dirt and mess										
The machines and tools are in optimal condition										
A clear flow of work has been defined for the manufacture of sweaters										
You have control of the incoming and outgoing orders										

5s Shitsuke: Foster a more aligned organizational culture. In which, the following 8 steps must be taken into account: create, build, form, enlist, enable, generate, sustain, institute. The Figure 4 shows the radar graph of the 5s internal audit.

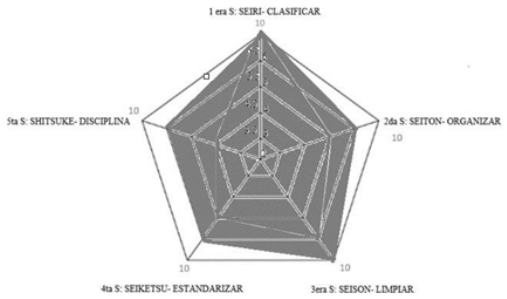

Figure 4. Radar Diagram

5.3.4 Kanban implementation

The objective is to avoid overproduction of products and have the production that must be carried out for each type of product. To do this, we seek to establish a Kanban board, where the company will be able to visualize the production that must be carried out for each type of product.

Figure 5. Kanban Implementation

5.4 Validation

For the next validation, Minitab was used, in which the t-student was taken into account to validate each variable. Therefore, with respect to the order quantity, an improvement in the order quantity of approximately 100 orders is displayed. In addition, there is a cycle time reduction of 2 minutes compared to what was before 5 minutes. Likewise, the company's profitability increased by 10%. This can then be seen in Figure 6.

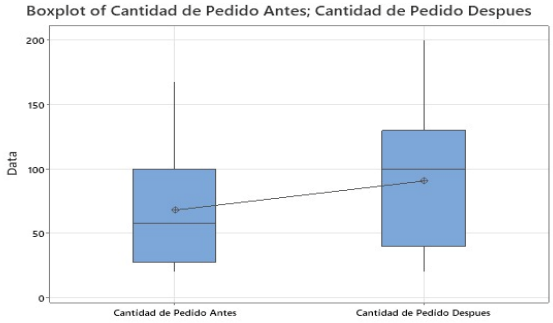

Figure 6. Kanban Implementation

6. Conclusion

The implementation of the proposed management model, which integrates the Kanban, ABC Classification, 5S and Demand Forecasting tools, has shown a considerable reduction in order non-compliance in the textile MPE in which it has improved from 60% to 30%. %. The application of the ABC Classification has made it possible to optimize inventory management, prioritizing items with the highest turnover and value, thus reducing storage costs and improving product availability. In the ABC Classification there was an improvement of 16% for category A. While in category B its improvement was negative with a decrease of 1156. For category C it was reduced to 205 products. Regarding the Kanban, obsolete products improved by 16%. 10%.Inventory efficiency improved by 15% and inventory rotation improved by 8%.Likewise, the implementation of Kanban and 5S tools has contributed to improving the efficiency of the production process and the workflow of the customer orders through the Kanban board in which there was a better visualization of the number of orders. The number of orders increased by 100 orders. Reason why, through the application of demand forecasting techniques, it has allowed the textile company to more accurately anticipate the needs of its customers, adjusting production to real demand. Likewise with safety stocks because before there was a quantity of 600 products in warehouse, however, by implementing the Forecast, the stock improved to 40 products.

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Biographies

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